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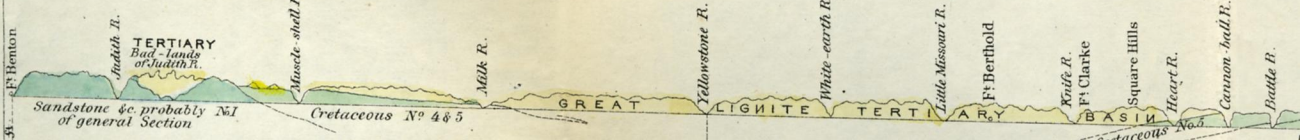
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Geological & Barometrical Section along the Missouri River from Ft. Benton





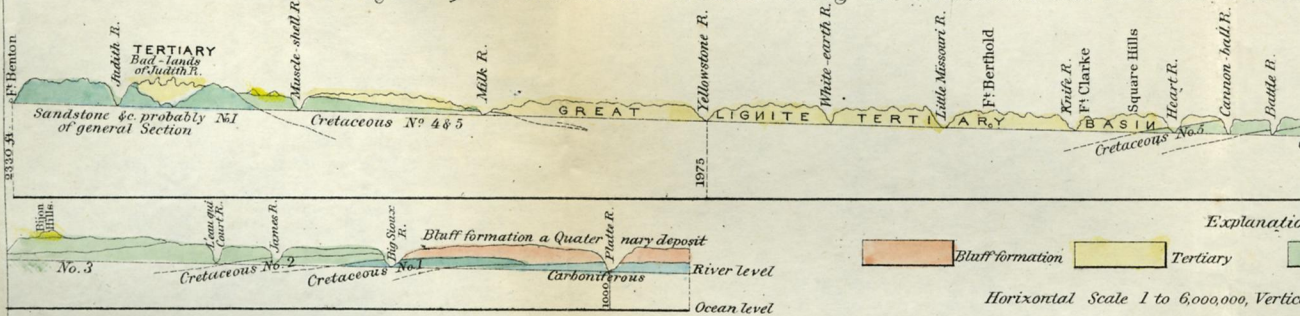
Cal Section along the Missouri River from Ft Benton to the Platte River



White R



Geological & Barometrical Section along the Missouri River from Ft. Benton





Geological Section along the Missouri River from Ft. Benton to the Platte River



Explanations of Colours

Bluff formation Tertiary Oretaceous 2345 Oretaceous No. 1 Carboniferous

Horizontal Scale 1 to 6,000,000, Vertical Scale 1 to 60,000, distorted 100 times.

back it out again, owing to the resistance of the branches on the ground and of other bushes, so, like the sailor who throws overboard a portion of his cargo to enable him to save the rest, they cut off this piece that they might steer clear of the difficulty with the remnant of their treasure. The chips are from the larger specimen; in cutting them out they must work horizontally around the trunk, and when they have cut two grooves at the proper distance apart, they take hold of the isolated portion with their teeth, and split off portions *vertically*, and so in succession split off chips until they have girdled the tree; a second course is then removed from the bottom of this, and so on diminishing the size of the chips until the tree is only supported by a portion of its heart connecting the apices of two cones—one on the stump upright, the other on the butt of the log inverted. In this manner, also, the Indians cut down trees with their hatchets, leaving the same form of a cone on the butt of the log and on the stump, as their beaver neighbors have done before them.

May 26th.

MR. S. ASHMEAD in the Chair.

The Committees to whom were referred the following papers, reported in favor of their publication :

“Notes Explanatory of a Map and Section illustrating the geological structure of the country bordering on the Missouri River, from the mouth of Platte River to Fort Benton, in lat. $47^{\circ} 30' N.$, long. $110^{\circ} 30' W.$, by F. V. Hayden, M. D.”

“Explorations under the War Department : Description of new Cretaceous and Tertiary Fossils collected by Dr. F. V. Hayden in Nebraska, under the direction of Lieut. G. K. Warren, U. S. Top. Engineer, with some remarks on the geology of the Upper Missouri country; by F. B. Meek and Dr. F. V. Hayden.”

“On the Larva of *Thyreus Abbotii*, by J. P. Kirtland, M. D.”

EXPLORATIONS UNDER THE WAR DEPARTMENT.

Notes Explanatory of a Map and Section Illustrating the Geological structure of the country bordering on the Missouri River, from the mouth of the Platte River to Fort Benton, in lat. $47^{\circ} 30' N.$, long. $110^{\circ} 30' W.$

BY F. V. HAYDEN, M. D.

(Communicated by permission of the Secretary of War.)

The facts from which the accompanying map and section have been constructed, are mainly the results of three years' explorations by me in the north west;* and although some of them have heretofore been given to the public in brief written accounts of the geology of that country,† this is the first time they have been presented in this form.

In regard to the Map, I would simply state that it is based on the most recent topographical explorations. The geology, however, is of course not

* The geology of portions of north-eastern Kansas has been colored on this map from information kindly furnished by Maj. F. Hawn, of Weston, Missouri, U. S. Dep. Surveyor in that region.

For the information respecting the geology of Platte River valley, I am indebted to Mr. Henry Pratten of the Geological Survey of Illinois.

† See several papers by Mr. Meek and the writer in 8th vol. Proceed. Acad. Nat. Sci., Philada.

colored with that minuteness of detail attainable where a regular geological survey has been made. It is therefore probable outliers of the Tertiary formations may exist at a few points where the color would indicate the presence of the older strata upon which they repose. It may also be the case that in some instances valleys have been excavated through the Tertiary so as to expose the Cretaceous strata, at a few localities near the junction of those systems which I have colored as Tertiary. Where any of the colors end abruptly against black spaces, I merely mean to indicate that the formation is known to extend that far, without pretending to say it may not occupy a greater area in that direction.*

As meagre as this map may appear, it is hoped it will not be considered void of interest, when it is borne in mind that it represents the geology of a country about much of which comparatively little accurate information has been published, and the most conflicting opinions are entertained. As an evidence of this, it is only necessary to state that in a comparatively recent publication issued under the sanction of the Geological Society of France, the author, with nearly all that had been published respecting the geology of this country before him, colors almost the whole of this area, which is now well known to be occupied by Cretaceous and Tertiary formations, as Triassic and Jurassic.

Respecting the section, it is perhaps only necessary for me to state, that so far as it represents a profile of the country, it has been constructed from the most reliable Barometrical measurements in the possession of the War Department. The relative thickness of the various formations is given from careful estimates, and not from actual measurements; it is believed, however, that they will not be found far from correct.

As a brief history of former explorations in the North West, together with descriptions of the new fossils, are given in another place in this number of the Proceedings, I shall here confine myself to a few general remarks respecting the geological formations represented in the map and section, and leave all details for another occasion.

The rocks of Nebraska Territory, so far as they have been determined, appear to be referrible to four of the great systems, viz. :—

I. CARBONIFEROUS.

III. TERTIARY.

II. CRETACEOUS.

IV. QUATERNARY.

That portion of Nebraska to which my attention has been directed, forms the area or basin drained by the upper Missouri river and its tributaries, but more immediately to the region bordering upon the Missouri itself, commencing at the mouth of the Platte river and proceeding thence to a point near the base of the Rocky Mountains.

SYSTEM I.—CARBONIFEROUS.

Ascending the Missouri river, we have the upper members of the Carboniferous system, or the Coal Measures, very well exposed at the mouth of the Platte, and extending up the river about fifty miles, where they dip beneath the water level of the Missouri. At Florence, seven miles above Omaha city, the bed of the river is formed of these limestones, and this is the last exposure of them which I observed in ascending the river.

It is difficult to estimate with much accuracy the thickness of the different beds, as the yellow marl or "Bluff Formation," a recent deposit, attains a great thickness in this region, concealing the limestone except in a few localities.

* By some mistake of the persons employed in New York to color the map, the little Tertiary basin at the mouth of Judith River, and several small outliers of Tertiary near White River, are colored a much deeper yellow than the deposits of that age on other parts of the map.

A very small exposure of Cretaceous rocks on the Yellowstone, just below the mouth of Power River, was by a similar error left out.

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The Coal Measures, when thoroughly studied, will be found to hold an important position among the geological systems of the far West. According to the investigations of Prof. Shallow, they extend down the Missouri river to Lexington, and we may safely say that they occupy that portion of Kansas bordering upon the river, and for a considerable distance into the interior. We have satisfactory evidence of their existence in the vicinity of Fort Laramie, and also that they occupy a considerable area near Great Salt Lake, Utah Territory.

Little is, however, known of the geology of these far western regions; our present information consisting for the most part of isolated facts.

SYSTEM II.—CRETACEOUS.

This system holds a very important position in the North West not only from the vast area which it occupies, but also in consequence of the number, variety, and beauty of its organic remains. The different formations, as they appear in ascending the Missouri, have been separated into five divisions, presenting generally well-marked lithological differences, and for the most part characterized by different species of fossils. I shall first speak of Formation No. 1 of the Vertical Section, presuming, however, that from all the information yet obtained, its geological position is not definitely determined. Thus far the weight of evidence seems to be in favor of its belonging to the Cretaceous System. We will consider it provisionally, therefore, as the lowest member of the Cretaceous System in this region, and as the first of the series of beds of that age seen in ascending the Missouri.

*Formation No. 1 of Vertical Section.**

In the order of superposition, Formation No. 1 rests directly upon the true limestones of the Coal Measures before referred to. Its first exposure seen along the Missouri is at Wood's Bluffs, right bank, about eighty miles above the mouth of the Platte, and it dips beneath the water level of the Missouri, a few miles below the mouth of the Vermilion. Its general character is a coarse grained, friable sandstone, very ferruginous, of a yellow or reddish yellow color, with thin beds of impure lignite and various colored clay. It contains very few fossils, mostly of the genera *Solen*, *Cyprina* and *Pectunculus*, also fossil wood, and numerous impressions of dicotyledonous leaves, similar to the common willow. Its entire thickness is estimated at ninety to one hundred feet, but it may be more. The relation which I suppose this formation holds to one of a similar character near the mouth of the Judith river will be noticed hereafter.

Formation No. 2 of Vertical Section.

This Formation is first revealed in thin outliers below the mouth of Big Sioux river, and on that stream six miles above its mouth it caps the Bluffs, apparently mingling to some extent with the succeeding bed, and containing at this locality large numbers of *Inoceramus problematicus* and fragments of fishes. Near the mouth of Iowa creek and above, it shows itself worthy of a separate position in the series. It is composed of a dark leaden gray laminated plastic clay, containing few fossils, but great quantities of the sulphate of lime in crystals, assuming a variety of beautiful forms. Its greatest thickness is seen five miles below the mouth of James river. At Dorion's Hills it is seen at low water mark. Entire thickness estimated at ninety feet. Fossils, *Ammonites*, *Inoceramus*, *Cytheria*, *Serpula*, *Ostrea* and abundant fish remains.

Formation No. 3 of Vertical Section.

The geographical distribution of this formation and its influence on the scenery render it one of the most interesting on the Missouri. It is first seen in thin outliers near the mouth of Big Sioux river, and becomes quite con-

* See Vertical Section in a paper by F. B. Meek and F. V. Hayden, in this number of the Proceedings of the Academy.
1857.]

spicuous on the summits of the Bluffs ten miles above Iowa creek. At Dorion's Hills it reaches to the water's edge and is the prevailing formation from thence to the foot of the Great Bend, where it passes by a gentle dip beneath the water level of the Missouri. At Dorion's Hills there is a fine section of this bed about eighty feet exposed above the water's edge, containing its most abundant and characteristic fossil, *Ostrea congesta*. In many places, as opposite the mouth of Running Water, it assumes the form of a long series of precipitous bluffs, giving a pleasing variety to the general monotony of the scenery. This is one of the principal characteristic external features of this formation.

The upper portions of this rock is a yellowish and gray calcareous marl, very soft and yielding, so that it is easily cut up into numerous ravines by the temporary streams, and thus the bluffs along the Missouri often present the appearance of a series of cones split from apex to base. The lower stratum, however, is more compact and forms a soft bluish gray limestone.

Though so well developed and covering so wide an area, the middle and upper portions, at least, of this rock can never be made useful for building purposes. Quite soft and friable in places, when detached, it absorbs moisture rapidly and crumbles in pieces. Being a rich calcareous marl, it may be used at some future time as a fertilizer.

The fossils of this formation, though belonging to few species, so far as is yet known, are numerous in individuals. A species of oyster (*O. congesta*) is found in great quantities throughout the bed, and in localities *Inoceramus problematicus* is abundant. Fish remains, though consisting mostly of scales and obscure fragments, are disseminated throughout the deposit, several species of which have already been identified and described by Dr. Leidy. Entire thickness of this bed about one hundred and fifty feet.

Near First Cedar island, a very singular bed makes its appearance superimposed on No. 3, which we shall consider as probably forming a local upper member of that formation. It extends up the Missouri river to a point near the Great Bend, a distance of about eighty miles. Lithologically it is a dull black, unctuous clay, destitute of any grit, and does not effervesce with an acid. It contains some carbonaceous matter and great quantities of Selenite in crystals.

Formation No. 4 of Vertical Section.

This Formation is the most important one in the Cretaceous System of the North West, not only in regard to its thickness and its geographical distribution, but also in its influence on the topographical features of the country. It is only second in interest to the succeeding bed in the number, beauty and variety of its organic remains. Commencing about ten miles above the mouth of James river, where it is seen only in their outliers capping the distant hills or bluffs, it continues gradually assuming a greater thickness as we ascend the Missouri until reaching the Great Bend, where it monopolizes the whole region, giving to the country underlaid by it a most gloomy and sterile aspect. At the Great Bend it attains a thickness of two hundred feet, and continues to occupy the country bordering on the Missouri to the mouth of Grand river, where, in consequence of the dip of the strata, it passes gradually beneath the water level of the river.

After dipping beneath the water level between Grand and Cannon Ball rivers, this formation again rises to the surface about thirty miles below the mouth of Milk river, (far up towards the sources of the Missouri,) by a reversed dip of the strata from beneath the northern portion of the Great Lignite Basin, as will be seen by reference to the section on the map. Near the mouth of the Muscle Shell river it occupies the whole country for a distance of about eighty miles, and thins out upon the tops of the hills near the mouth of the Judith river.

On the Yellow Stone I observed Formation No. 4 in but one locality, about eighty miles above the mouth of that river. It does not attain a great thick-

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ness, and is probably a ridge left after the denudation of the Cretaceous strata previous to the deposition of the Tertiary. Neither the Cretaceous beds, nor the Tertiary that overlies them, exhibit in this vicinity any evidences of upheaval. The Cretaceous strata here have an extent of only about eight miles, and are exposed only along the banks cut by the river, yet in that space they reveal the remains of marine mollusca in a profusion which I have seen in no other locality. The whole thickness exposed on the Yellow Stone does not exceed twenty-five feet above the water level, and the distant hills on either side are composed of Tertiary beds. At this locality the fossils show a complete blending of this and the succeeding bed, in the ascending series.

We will now return to White or Smoking Earth river below Fort Pierre, and trace this formation into the interior of that interesting region. Passing up the valley of White river, we find it occupying the country bordering upon that stream for about fifty miles above its mouth. Near this point outliers of the White river Tertiary Basin begin to cover the highland, and No. 4 is seen along the river for about twenty miles farther, when it is concealed by Tertiary strata. The intervening country east and north east of the Bad Lands to the Shyenne river, a distance of one hundred and fifty miles, is for the most part underlaid by this bed, except an extension of Fox Ridge, to the sources of the Teton river, which is composed of Formation No. 5 of the Vertical Section. The extensive area drained by the Shyenne river is composed of No. 4, excepting the sources of a few of its tributaries. Sage and Bear creeks take their rise in the White river Tertiary Basin, but flow mostly through this Formation, revealing large quantities of Cretaceous fossils. A few small tributaries have their origin in the Fox Ridge, and Cherry river has its source in the Lignite Tertiary Basin, near the head waters of the Little Missouri.

In summing up the extent of country underlaid by this great formation, we find that south of the Lignite Basin, it occupies an area of two hundred miles in length and one hundred in breadth, or twenty thousand square miles. North of the Great Lignite Basin, commencing at its first appearance near Milk river, we find it covering an area of two hundred miles in length and sixty in breadth, or about twelve thousand square miles. I have been thus particular in estimating its approximate limits and extent of surface on account of its influence on the future destiny of that region. Wherever this deposit prevails it renders the country more completely sterile than any other geological formation I have seen in the north-west. We see from the above estimate that it renders barren over thirty thousand square miles of the valley of the Missouri.

The fossils of this formation are too numerous to mention in detail. The upper and lower members appear to be exceedingly fossiliferous, while the intervening portions of considerable thickness contain only a few imperfect specimens of *Cephalopoda* and the bones of *Mosasaurus missouriensis*. The entire thickness of this formation may be estimated at about three hundred and fifty feet.

Formation No. 5 of Vertical Section.

This very interesting bed, though differing lithologically from the preceding one, contains many of the same species of fossils. It is worthy, however, of a distinct position in the series, not only from its extent, thickness and difference of composition, but also from the more favorable influence that it exerts upon the country underlaid by it. In ascending the Missouri river it first makes its appearance near the mouth of Grand river, about one hundred and fifty miles above Fort Pierre. Near *Butte aux Gres* it becomes quite conspicuous, acquiring a thickness of eighty or one hundred feet, and containing great quantities of organic remains. Here it forms an extension of what is called Fox Ridge, a series of high hills having a northeast and southwest course, crossing the Missouri river into Minnesota at this point. Its north eastern limits I have not ascertained. In its south western extension it continues for a considerable distance nearly parallel with the Missouri crosses the Moreau river about 1857.]

thirty miles above its mouth, then forms a high dividing ridge between the Moreau and Shyenne rivers, at which locality it first took its name. Continuing thence its south westerly course, it crosses the Shyenne, and is seen again in its full thickness at the heads of Opening creek and Teton river, forming a high ridge from which tributaries of the Shyenne and Teton take their rise. The little streams flowing into the Shyenne have a north westerly course, while those emptying into the Teton take a south easterly direction. We thus find that this bed underlies an area of about two hundred miles in length and fifty miles in breadth, or about ten thousand square miles.

The general character of Formation No. 5 is a yellow arenaceous and argillaceous grit, containing much ferruginous matter, and in localities a profusion of Molluscan fossils. It forms a much more fertile soil, more healthy and luxuriant vegetation, sustains a finer growth of timber than Formation No. 4, and abounds in springs of good water.

Like No. 4, this bed yields in the greatest abundance quite perfect and well preserved organic remains. Many of the species approximate so closely to Tertiary forms, that did we not find them everywhere associated with Ammonites, Scaphites and other genera which are not known to have existed later than the Cretaceous epoch, we should at once pronounce the formation in which they occur Tertiary. The whole thickness of this bed is estimated at one hundred to one hundred and fifty feet.

SYSTEM III.—TERTIARY.

This system occupies an extensive area in the country bordering on the Missouri valley. Its wide geographical distribution, its influence upon the topographical features of the country, the mixed and somewhat peculiar character of its organic remains, render its study of the highest interest to the geologist and palæontologist. It seems to occupy depressions in the Cretaceous strata, as is shown in the illustrative section. I shall speak of this system on the Upper Missouri as they occur, or as three distinct basins, the intervening portions being occupied by rocks, which, as far as has been determined, belong to the Cretaceous epoch.

The Basins of this systems are as follows:—

1st.—*Les Mauvaises Terres*, or Bad Lands of White river, which with their outliers occupy an area of from two hundred to two hundred and fifty miles in length and one hundred to one hundred and fifty in breadth. Exact limits not yet ascertained.

2nd.—The Great Lignite Basin, commencing near the mouth of Cannon Ball river and extending nearly to the mouth of the Muscle Shell river, a distance of about six hundred miles. I have traced this formation up the Yellow Stone to the mouth of the Big Horn river, a distance of three hundred miles. Its limits have not been ascertained in several directions.

3rd.—The Bad Lands of the Judith river, which occupy an area of forty miles in length and fifteen to thirty in breadth, reposing upon a sandstone, the age of which has not been positively determined.

Basin 1st.—*Bad Lands of White River.*

This most remarkable lacustrine deposit has been comparatively but recently made known to the scientific world. Wonderful not alone for its unique scenery, but also for the abundance and importance of its organic remains. Even as yet it has been but partially explored, and yet the results that have been obtained have proved of the highest interest. The profusion of Mammalian and Chelonian remains contained in this deposit of species and in most cases genera, though closely allied yet differ from all known living forms, which must render it, when fully explored and studied, classic ground to the geologist and palæontologist. A history of the progress of its exploration up to 1853, with elaborate descriptions of many of its organic remains, may be found in a magnificent memoir entitled "The Ancient Fauna of Nebraska," written by Prof. Joseph Leidy, and published by the Smithsonian Institution.

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In their lithological characters these deposits differ very materially from those of the two succeeding basins, being composed of whitish clays and calcareous and siliceous marls and grits, and entirely destitute, so far as known, of any vegetable remains, except very rare fragments of silicified wood. It is chiefly remarkable as being a vast deposit in which were entombed immense numbers of Mammalian and Chelonian animals, for the beauty and perfection with which their bones have been preserved, and its unique scenery. The few Molluscous fossils which have been found, show most conclusively its purely fresh water origin, being confined to the genera *Helix*, *Planorbis*, *Limnea*, &c. We have also at this time very conclusive evidence that it belongs to the Miocene age.*

The main body of the Bad Lands of White river covers an area of about one hundred miles in length and fifty to sixty in breadth, and it is that portion chiefly which is represented on the map. We have satisfactory evidence, however, from its outliers, that it once occupied a very much larger area, and that it has been removed by denudation. In the section it is represented by Big Ox and Medicine Hills, these localities revealing the only indications of it along the Missouri river. We have also evidence of its existence to a greater or less extent throughout the valley of the Running Water, also that it covers large portions of the country bordering upon the Platte, especially on its North Fork, and a much larger space might be colored on the map, but we have preferred to let it represent what is now known with considerable precision, and wait for the results of future labors to render our knowledge more complete.

Basin 2nd.—Great Lignite Deposit.

This basin occupies a more extensive geographical area on the Missouri than that of the other two united. It has been known since the expedition of Lewis and Clark that a vast formation existed on the Upper Missouri, containing Lignite, &c. Information of a like nature has been published by former explorers since that time, but without details of its lithological characters or collection of its fossils that would enable us to determine its age or extent. The collections of fossils now obtained show most conclusively that it possesses the mixed character of a fresh water and estuary deposit, and that it cannot be older than the Miocene period. It is composed mostly of clays, sands, sandstone and lignites, and has already yielded numerous animal as well as vegetable fossils of great perfection and beauty. It is chiefly remarkable, however, for the evidence that it reveals to us of the variety and luxuriance of the flora of that period. In this respect it differs more especially from the other two deposits.

The extent of country known to be occupied by this basin I have estimated at four hundred miles in length and one hundred and fifty in width, or about sixty thousand square miles. We thus come to an approximate idea of the immense area occupied by this formation, though I am satisfied that when it is thoroughly studied it will be found that the above estimate is much too low.

Basin 3rd.—Bad Lands of the Judith.

This exceedingly interesting deposit occupies a depression in a sandstone formation which rises to the water level at the mouth of Little Rocky Mountain creek from beneath the well-known Cretaceous bed No. 4 of the Vertical Section. It presents perhaps the most rugged scenery on the Missouri river, the denudation and erosion having been much greater than at the Bad Lands of

* See a paper by Prof. Leidy in the Proceedings of the Academy for March, 1857, also the succeeding paper by F. B. Meek and F. V. Hayden, in this number of the Proceedings.

White river. But the most remarkable feature of this basin is the wonderful disturbance of the strata. So much are the beds disturbed and blended together by forces acting from beneath, that it seems almost hopeless to obtain a section showing with perfect accuracy the order of superposition of the different strata.

The lignite beds throughout this basin, though well marked, are of so earthy a character as to have ignited spontaneously in but few places. Indeed the impurity of the lignite forms the most essential lithological difference between this deposit and the Great Lignite Basin below Fort Union. In some places metamorphic rocks have been thrown up through the entire thickness of the strata. Some remarks upon the age of this deposit will be found in a succeeding paper by F. B. Meek and the writer.

FORMATION No. 1 ? OF THE GENERAL SECTION,

As seen near the mouth of Judith river.

Although the formation of which I am about to speak has already revealed many important facts, the organic contents of its strata differ so materially from those of any other with which I am acquainted in the North West, that we are unable to fix with certainty its position in the geological scale. From its lithological characters we may refer it to No. 1 of Vertical Section, no difference being seen more than would be expected from their widely separated geographical positions. These facts have already been published in the Proceedings of the Philadelphia Academy of Natural Sciences, from which I extract the following paragraph:*

"In our section of the Nebraska formations, given in a paper published in the 8th vol. of the Proceedings of the Academy, page 63, it will be remembered we placed provisionally the beds of sandstone and clay composing formation No. 1, seen at the Mouth of Big Sioux river and below there, along with the Cretaceous strata, stating at the same time that they were not positively known to belong to that system. We still think it barely possible these beds may be older than Cretaceous, though if represented, as we think they are, by similar beds seen holding about the same position near the mouth of Judith river, far up towards the sources of the Missouri, we must either refer them to the Cretaceous system, or admit the introduction of the genus *Baculites* before that epoch, as we have fragments of a small species of that genus from the Judith river beds. At the same time it should be borne in mind that these strata at the last named locality are characterized by a group of fossils remarkably distinct from those in the rocks above, and that one species belongs to the genus *Hettangia*, a type of bivalves, not known to occur, in the old world, in more modern formations than those of the age of the Lias. If not older than Cretaceous, we think, from these facts, as well as from the stratigraphical position of these beds, they probably represent some of the older members of that system."

Although all our information as yet obtained respecting this sandstone formation is obscure, we have indications that when thoroughly studied, it will prove one of the most important and widely distributed in the far West. From all the evidence I can obtain after a careful study and comparison of these beds, with the minute descriptions of Sir John Richardson, and still later those of Mr. Isbister, I am led to believe, with some confidence, that this formation is but a southern extension of the great lignite formations mentioned by those gentlemen as stretching along the eastern slope of the Rocky Mountains, far northward to the Arctic sea. Though, as suggested in a former paper by Mr. Meek and me, some of these lignite deposits in the north western portions of the British possessions may belong to the Tertiary epoch.

* See a paper by F. B. Meek and F. V. Hayden, in *Proc. Acad. Nat. Sci.* November. 1856

EXPLORATIONS UNDER THE WAR DEPARTMENT.

Descriptions of new Species and Genera of Fossils, collected by Dr. F. V. Hayden in Nebraska Territory, under the direction of Lieut. G. K. Warren, U. S. Topographical Engineer; with some remarks on the Tertiary and Cretaceous formations of the north-west, and the parallelism of the latter with those of other portions of the United States and Territories.

BY F. B. MEEK and F. V. HAYDEN, M. D.

(Communicated by permission of the Secretary of War.)

Most of the fossils, and many of the notes and memoranda upon which this paper is based, although collected previous to the presentation of our last communication to the Academy, arrived in the States since that paper was in print. Consequently, we have now not only the means of adding many new and interesting species to the list of ancient mollusca previously known from Nebraska, but the late explorations of Lieut. Warren have also brought to light some additional information in regard to its general geology, which we have embodied in the following remarks.

Before presenting these facts and conclusions, justice to former explorers requires that we should at least give a brief statement of the results of such expeditions as have contributed to the development of the geology of this region.

The first reliable accounts we have of the general physical characters of the upper Missouri country, were given to the world in the report of Lewis and Clark's expedition to the Columbia in 1804—5—6. The explorations of these gentlemen, in addition to bringing out a large amount of information of a different character, established the fact of the occurrence of Cretaceous rocks at the Great Bend of the Missouri below Fort Pierre, and of the existence of what was supposed to be "stone coal" (Lignite,) in the Mandan country. Various beds of clay, sand, sandstone, &c., were mentioned in their report, but without any suggestions respecting their age.

In 1832, the Prince of Neu Wied and party also ascended the Missouri to its sources; and the results of his explorations, embodying a great amount of highly interesting information respecting the geography, natural history, &c., of the country explored, has been published in the form of a large quarto volume, accompanied by a magnificent folio atlas of plates, illustrating the scenery of the country, and the manners and customs of its native tribes, in a style of art rarely equalled on this side of the Atlantic. Respecting the geology of the country, however, the Prince's expedition added little of importance beyond the discovery of *Mosasaurus Missouriensis*, to the results of Lewis and Clark's expedition.*

Mr. Nicollet, the well known Geographer, visited this country in 1839, ascending the Missouri to Fort Pierre, and making on his way up a fine collection of Cretaceous fossils at the Great Bend.† Although passing rapidly through the country, he formed a tolerably correct idea of its geology, and gave in his report a vertical section of the Cretaceous rock seen below Fort Pierre, which is correct, excepting that he seems to have had no knowledge of No. 2, and as we think, without sufficient reason, represented two of the subdivisions of No. 3 as distinct formations; No. 1 he appears to have referred to the carboniferous system. As he did not go above Fort Pierre, he probably saw nothing of No. 5, though some of its characteristic fossils were presented to him by gentlemen connected with the Fur company.

*The Prince lost nearly all of his geological specimens by the burning of the Fur Company's steam boat.

† These, together with others given to him at Fort Pierre, were investigated by Dr. Morton, and published in the Jour. Acad. Nat. Sc. Philada., Vol. 8, p. 207.

In 1843, Mr. Edward Harris, who accompanied the distinguished Ornithologist Audubon to the mouth of Yellowstone River, brought back specimens from various localities along the Missouri River, some of which verified the statements of former explorers, while others gave evidence of the existence of a fresh-water formation near Fort Union.

At various times after this, specimens of mammalian remains were brought in by gentlemen connected with the American Fur Company, indicating the existence of an interesting tertiary deposit on White River; the first account of which was published by Dr. H. A. Prout, of St. Louis, in the American Journal of Science, 1847.

In 1849, Dr. John Evans, one of Dr. Owen's assistants in the geological survey of the Chippeway Land District, was sent by that gentleman on an expedition to the Mauvais Terres of White River, and brought back a fine collection of Mammalian and Chelonian remains, which were investigated by Prof. Leidy, of Philadelphia. He also collected at the Great Bend, Sage Creek, and Fox Hills, many interesting Cretaceous fossils, which were investigated by Dr. D. D. Owen, and published in his final report in 1852. Dr. Evans' observations, embracing a section of the Bad Lands, together with a description of their physical features, were also published in this report.

In the following year Mr. Thaddeus A. Culbertson visited the Upper Missouri country under the auspices of the Smithsonian Institution, during which expedition he collected some interesting vertebrate remains from the White River formations. He also ascended the Missouri on the Fur Company's boat to a point above Fort Union, noting the character of the face of the country, and the occurrence of lignite beds at various localities.

In the spring of 1853, Dr. Evans again visited this country incidentally, while on his way to Oregon Territory, in the geological survey of which he was engaged, under the patronage of the general government. During this expedition he made another extensive collection of vertebrate remains, and some fresh-water mollusca at the Bad Lands of White River, as well as some interesting Cretaceous fossils from Sage Creek. The mammalian remains of this expedition were studied by Prof. Leidy, and the other fossils by Dr. Evans and Dr. Shumard, and published in the Proceedings of the Acad. Nat. Sc. at Philadelphia, and the Acad. Sciences of St. Louis.

At the same time (1853) the writers of this paper were employed by Prof. James Hall, of Albany, N. Y., to visit the Bad Lands of White River, for the purpose of making a collection of the Tertiary and Cretaceous fossils of that region. This expedition brought back an extensive and interesting collection of vertebrate remains from the Bad Lands, and of Cretaceous fossils from Sage Creek, as well as from the Great Bend and other localities along the Missouri below Fort Pierre. The first were investigated by Prof. Leidy, and published in the Proceedings of the Acad. Nat. Sc. at Philadelphia; and the latter by Prof. Hall and one of the writers,* and published in the Transactions Acad. Arts and Sciences, Boston.

In this latter paper a brief vertical section of the rocks seen during the expedition, and a complete list of all the mollusca then known from the Cretaceous and Tertiary rocks of that country, were given. The fact that the fossils characterizing the Cretaceous formations of Texas and New Mexico belong to different types from those occurring in the northwest, was also in this paper made known for the first time, in the following words: "Among all the collections made in Texas by Dr. Roemer and others, and of all those brought by the Boundary Survey Expedition, and other surveying and exploring parties, which we have seen, there is but a single species which we regard as doubtfully identical with one from Nebraska. This is *Inoceramus Barabini*, Morton, (*I. Crispii*, Mantell (?))."

A summary of the leading results of this expedition, throwing light upon

* Mr. Meek.

the general geology of the country, its soil, scenery, &c., was likewise given to the public by Prof. Hall, in an interesting paper read before the American Association for the Advancement of Science, at the Providence meeting.

Subsequent to all these expeditions, one of the writers* again visited Nebraska, and spent two years in traversing various portions of that country; part of which time he was aided by Col. A. J. Vaughan, Indian agent, and afterwards by Mr. Alexander Culbertson, and other gentlemen of the American Fur Company. During this expedition he explored the Missouri in the vicinity of Fort Benton, and the Yellow Stone to the mouth of Big Horn River. Also considerable portions of the Bad Lands of White river, and other districts not immediately bordering on the Missouri. The vertebrate remains collected by him, as may be seen by reference to the various papers by Prof. Leidy in the Proceedings of the Academy, embrace a larger number of species than all those previously known from that country, many of which belong to new and remarkable genera. Large collections of mollusca were also obtained from the Cretaceous and Tertiary formations, and have since been published by us, together with remarks on the general geology of the country, in a series of papers in the Proceedings of the Academy Nat. Sc. Phila. Vol. viii.

Again, in 1856, the same one of the writers returned to that country in connection with a government expedition under the direction of Lieut. G. K. Warren. The new Cretaceous and Tertiary invertebrate remains, together with the new facts in regard to the geology of the country, collected by this expedition, form the basis of this paper.

Up to the publication of our first paper, about fifty-six new species of Cretaceous and Tertiary mollusca had been published from Nebraska, by Drs. Morton, Owen, Evans and Shumard, and by Prof. Hall and one of the writers. Since that time, sixteen additional new species have been published by Drs. Evans and Shumard, making in all seventy-two species hitherto published by others from that country. Our own investigations (including those here described) have made known one hundred and fifty new species, and two new genera, many of the former of which also belong to types not hitherto recognized in this country. Of these one hundred and fifty species, fifty-four (if we include the Judith River, freshwater and estuary species) belong to the Tertiary system, and ninety-six to the Cretaceous. Fifty of the Tertiary species belong to fresh water and land types, and four to genera inhabiting salt and brackish waters; being about four-fifths of all the land and freshwater Tertiary species hitherto made known from American formations. The geological position, and vertical range of all our new species, and several of those published by others from the north-west, as well as a number of the well known and widely distributed forms such as *Scaphites Conradi*, *Ammonites lobatus*, *A. placenta*, *Nautilus Dekayi*, *Inoceramus problematicus*, *Mosasaurus Missouriensis*,† &c., have been determined with considerable accuracy; so that we have now the means of tracing out the parallelism between these deposits and their equivalents in other countries.

In a general vertical section of the Nebraska formations given in a paper communicated by us to the Academy in November last, it will be remembered, we represented the White river Tertiary formations as on a parallel with the Eocene, or oldest member of that system. In doing this we merely followed the published views of others, without intending to give it as the expression of an opinion based on any of our own investigations; as all the organic remains yet found in that basin, with the exception of a few freshwater shells described by

* Dr. Hayden.

† In a section of the Nebraska formations accompanying the last paper communicated by us to the Academy, we gave as the position in which the remains of *Mosasaurus* occur in the north west, the upper part of No. 5. This was in consequence of erroneous information in regard to the locality from which the specimens given to the Prince of Neu Wied were obtained. The locality (at the Great Bend of Missouri) has since been visited by one of us, and many specimens obtained; they occupy a horizon about the middle of No. 4 of the section.

Drs. Evans and Shumard, belong to the vertebrata, and are consequently out of our line of investigation.

During the later explorations in that region, facts were observed tending to throw doubt upon the conclusion that these formations belong to the Eocene epoch. Among other facts of this nature, we would mention that a friable sandstone seen crowning some of the hills near Moreau River, in which specimens of a *Cyrena* described in one of our former papers (*C. Moreauensis*) and *Ostrea subtrigonalis* (E. & S.), were found associated with large bones supposed to be those of *Titanotherium*, and which bed we had regarded as probably a distant outlier of the White river formations, was found to be the same as the lowest bed of the Great Lignite basin extending far to the northward.

Now as the *Titanotherium* bed of the White river basin is the oldest member of that series, it must be manifest if the species of the *Titanotherium* occurring at these two localities are really identical, we must either admit the remains of that animal had a great vertical range, which is not the case in the White River deposits, or suppose these two basins are nearly or quite exactly on a parallel.

In addition to the foregoing, some Miocene deposits seen crowning the summits of hills on the east side of the Missouri, near the mouth of White River, were traced by a series of outliers up the valley of the latter stream, to where they were found to pass into the upper part of the well known Mauvaises Terres, extending towards the sources of that stream, and which have furnished so many interesting vertebrate remains.

After comparing and discussing these facts we suspected that the whole of the White River basin might be more properly of Miocene than Eocene age, and upon glancing over D'Orbigny's tables showing the vertical range of the various genera of fossil vertebrata, and consulting Pictets *Traité de Palæontologie*, we observed that several of the old genera to which Dr. Leidy refers the White River *Mammalia* are regarded in the Old World as characteristic of the Miocene epoch. These enquiries, however, being out of our line of investigation, we wrote Prof. Leidy, the distinguished comparative anatomist of Philadelphia, who has so ably investigated all the vertebrate remains hitherto brought from Nebraska, stating our doubts and suspicions respecting the age of these deposits, and requesting him to examine very carefully the large water-worn bones from Moreau and Grand Rivers, occurring in what we knew to be the lowest bed of the Lignite basin, and to inform us if he was quite satisfied they are identical with *Titanotherium Prouti*; also making enquiries respecting the Eocene or Miocene affinities of the various new genera of *Mammalia* described from the Bad Lands of White River by him. Since that time we were much gratified to learn from Prof. Leidy that as much as three or four weeks previous to the reception of our letter, he had arrived at the conclusion, from purely palæontological evidence, that the White River deposits must belong to the Miocene epoch.

Prof. Leidy has presented his views in regard to the Miocene affinities of the vertebrata from the White River formations, in some interesting remarks accompanying a complete catalogue of all the organic remains described by him from Nebraska, recently read before the Academy; a copy of which he has kindly placed in our hands in advance of the regular issue of the Proceedings. From these remarks we extract the following in reference to the fossils from the White River basin:

"*Oreodon*, *Agriochoerus*, *Pæbrotherium*, *Leptomeryx*, *Leptauchenia*, *Protomeryx*, *Merycodon*, *Titanotherium*, *Leptochoerus*, *Hyracodon*, *Merychippus*, *Ischyromys*, *Palæolagus*, *Eumys*, *Dinictis* and *Leptarctus*, are peculiar, extinct mammalian genera, from the Tertiary formations of Nebraska, which have heretofore been generally viewed as belonging to the Eocene period, but from their affinities, the associated genera, and the absence of others so common in the Eocene deposits of Europe, I suspect rather belong to the Miocene period. The first seven genera above mentioned are true ruminants, with teeth constructed upon the same type

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as those of living ruminants; a type which is not found in the Tertiary deposits of Europe and Asia, earlier than the Miocene period.

Entelodon, *Palæochærus*, *Rhinoceros*, *Hipparion*, *Steneofiber*, *Amphicyon*, and *Machairodus*, are common to the Nebraska Tertiary deposits and to the Miocene and later Tertiary deposits of Europe; and they have not been found in the Eocene formations of the latter continent.

Of the genera *Anchitherium*, *Hyopotamus* and *Hyænodon* species are found common to the Nebraska Tertiary deposits and the European Eocene and Miocene deposits.

Remains of *Palæotherium*, *Anoplotherium* and *Lophiodon*, so common in the Eocene formations of Europe, are entirely absent from the Nebraska Tertiary formations.

Titanotherium of Nebraska most nearly approaches the Miocene *Chaliocotherium* of Europe and Asia.

The rodents *Ischyromys*, *Palæolagus* and *Eumys*, most closely approach the *Arctomys*, *Lepus* and *Mus* of European Miocene and later deposits.

Very numerous remains of *Testudo* are found in association with the Nebraska Tertiary mammals; and extinct species of the same genus belong generally to the Miocene and later deposits of Europe."

From all the foregoing facts, the Miocene age of these White River formations may, we think, be regarded as established, both by palæontological and stratigraphical evidence. There are, however, many points of interest in regard to the exact parallelism of these deposits with those of the Great Lignite basin, yet unsettled. If it be true that the large bones previously referred to in both basins, do really belong to the same species of animal, it would seem, from the fact that they occur in the lowest bed of each, that the two basins are not merely both Miocene, but exactly on a parallel. If so, it is very difficult to account for the fact that, out of the numerous organic remains hitherto found in the two deposits, not a single species, excepting *Titanotherium Prouti*,* should be common to both; especially when we bear in mind the fact that the two basins approach to within forty or fifty miles of each other.

It is true, several of the *Mollusca* occurring in the bone bed, or lowest stratum of the Lignite basin, belong to genera only found in salt or brackish waters, and that none but terrestrial and fresh-water types have yet been found in any part of the White River deposits; thus indicating that one is a lacustrine formation, and the other an estuary deposits; conditions, it is true, not very favorable to the existence of the same species of *mollusca*, but hardly sufficient, we think, to account for the fact that all the shells hitherto collected from the lignite formations are not merely different species from those described by Drs. Evans and Shumard, from the White River beds, but belong to slightly different types.

The entire absence, so far as we yet know, of the fossil plants occurring in such great abundance in the Lignite formations, in those of the White River basin, is also worthy of note; while the lithological differences between the two deposits are well marked. The latter point of difference will be more obvious on comparing the following section of the Lignite formations taken by one of us,† at a locality thirteen miles above Fort Clark, on the right bank of the Missouri, with the section of the Bad Lands of White River, as given by Dr. Evans in Dr. Owen's Report, page 200.

* Since these remarks were communicated to the Academy, we have been informed by Prof. Leidy that he now rather suspects the large bones here alluded to belong to a huge *Dinosaurian* described by him from these beds, under the name of *Thespesius*. He further states that he had merely referred them provisionally to *Titanotherium Prouti* from their great size, as none of them he has yet seen show even the articulating extremities.

† Dr. Hayden.

Section of Tertiary beds thirteen miles above Fort Clark.

A	30 feet.	Ferruginous sandy marl passing downwards into variegated argillaceous grits.
B	2 inches.	Seam of impure reddish lignite.
C	10 to 12 feet.	Yellowish-gray friable grit, with numerous argillaceous concretions in horizontal layers, containing beautiful impressions of leaves, like those of <i>Platanus</i> , <i>Acer</i> , <i>Ulmus</i> , &c.
D	3 inches.	Seam of lignite, very much mixed with clay and sand.
E	10 feet.	Yellowish-gray grit, very friable, and containing argillaceous concretions charged with leaves of same species of plants as above.
F	3 inches.	Seam of earthy lignite
G	15 feet.	Yellow and drab clay and friable sandstone, containing argillaceous concretions with remains of plants like those above.
H	4 inches.	Dark reddish earthy lignite.
I	20 feet.	Yellow arenaceous grit—very friable—no fossils seen.
J	15 feet.	Alternations of lignite and clay. This bed is variable in thickness, as well as in the proportions of the materials, at different localities.
K	40 feet.	Heavy-bedded gray and ferruginous friable sandstone, containing <i>Melania Nebrascensis</i> , <i>Paludina multilineata</i> , <i>Bulimus limneiiformis</i> , <i>Corbula mactriiformis</i> , &c. &c.
L	2 feet.	Seam of impure lignite.
M	4 feet.	Gray argillaceous friable grit.
N	2 feet.	Lignite—purest in the section.
O	6 feet.	Bluish-gray clay, slightly arenaceous.
P	2 feet.	Rather pure lignite.
Q		Gray Compact, or somewhat friable concretionary sandstone.

The bed Q of this section is here only seen at low stages of the river, and then but a few feet of it is exposed above the water line. Near Long Lake, however,
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and on the Moreau, the entire bed is exposed, and attains a thickness of about thirty feet. At these latter localities it is seen to repose directly upon No. 5, or the most recent member of the Cretaceous system of the north-west, the upper part of which it so nearly resembles in its lithological characters that the line of demarkation between the two can often be only ascertained by the organic remains characterizing each. This fact, together with the general resemblance of many of the fossils found in the upper part of No. 5 of our general section to Tertiary types, would have caused us to doubt the propriety of referring this part of that bed to the Cretaceous epoch, were it not for the presence of *Scaphites Conradi*, and other well marked Cretaceous forms.

From the estuary character of the fossils found in the bed Q of the last section, (*Cyrena*, *Ostrea*, *Melania*, &c.,) and the absence of Cretaceous forms, we think there can be little room to question the propriety of referring it to the Tertiary system. The question, however, in regard to its exact position in that system may yet be regarded as a little doubtful, but the weight of evidence is on the side of the conclusion that it is Miocene. This conclusion is also borne out or strengthened by the general relations at other localities between this bed and those above, in which Miocene fossils occur.

The preceding section, although not representing all the beds of the great Lignite basin, (there being some higher beds seen at other localities,) gives a correct idea of the composition and general structure of these deposits,* and shows how remarkably they differ in their lithological characters from those of the White River basin, in which fine white argillaceous material so largely predominates, and no lignite or remains of plants have been found.

Of the age of the fresh-water and Estuary deposits seen near the mouth of Judith River, we have refrained from the expression of any very decided opinion, in consequence of the fact that they appear to be mingled by upheavals with a series of sandstones, clays, lignite, &c., which we think belong to the same epoch as No. 1 of our general section. Amongst some of the collections investigated by us from these Judith River estuary and fresh-water beds, and published in one of our former papers, we found species of *Paludina*, *Corbula*, &c., so closely related to shells we had from the Great Lignite basin near Fort Clark, that we were for a time in some doubt about the propriety of considering them distinct. In this upper member of the Judith River formations, great numbers of a small oyster occur along with the fresh-water shells of which we have just spoken. This oyster so nearly resembles a species in our possession from the lowest bed of the last section, obtained at a locality near Grand River, that we have not yet seen any characters by which they can be distinguished. We are also inclined to regard these shells as identical with a species described by Drs. Evans and Shumard from Grand River, under the name of *O. subtrigonalis*. There is also, in the fresh-water beds at the Judith localities, a *Unio*, which we think the same as a shell found in the Miocene lignite formations on the Yellow Stone. In addition to these facts, a species of *Trionyx* described by Dr. Leidy, from about the middle bed of the Judith fresh-water deposits, is regarded by that gentleman as identical with specimens from the bed Q, near Long Lake below Fort Clark.

Now as this bed Q, of the previous section at the Moreau, Grand River, and Long Lake localities, beyond all doubt, rests directly upon formation No. 5 of the general section, and forms a part of the Great Lignite series, we would not for a moment hesitate in regarding the deposits of which we have spoken, near the Judith, as Tertiary, were it not for the fact that the saurian and fish remains occurring in these beds, as may be seen by reference to Prof. Leidy's remarks respecting them, are allied to Wealden and older types.

In the midst of evidence of such a conflicting nature, it is of course unsafe to express any very positive opinion respecting the age of these formations. At

*It should be borne in mind, however, that the beds of lignite represented in this section vary much in extent, as well as in purity, at different localities; some of those seen on the Yellow Stone being as much as seven feet in thickness. At Fort Berthold, on the Missouri, a two foot bed is pure enough to be used as fuel.
1857.]

the same time, as we are strongly inclined to the conclusion that they will prove not merely Tertiary, but about of the age of the lowest beds of the Great Lignite basin, or perhaps a little older, we have therefore placed them provisionally along with the Tertiary beds in the accompanying general section of the Nebraska rocks.

In order to give some idea of the nature and order of superposition of the beds of which we have just been speaking, as well as for the sake of comparison with those of the Great Lignite basin, we give below a section taken at the mouth of Judith River, where these beds are least disturbed, and their stratigraphical arrangement can be best seen.

Section of Fresh-water and Estuary Deposits near the Mouth of Judith River.

A	80 feet.	Yellow arenaceous marl passing downwards into gray grit, with small seams of lignite; contains great numbers of <i>Ostrea subtrigonalis</i> ?, <i>Cyrena occidentalis</i> , <i>Melania conveza</i> , &c. &c.
B	10 feet.	Impure lignite, containing much sand. <i>Ostrea subtrigonalis</i> ? and silicified wood.
C	80 feet.	Alternations of sand and clay, with particles of lignite; also reddish argillaceous concretions with a few saurian teeth, and fresh-water shells.
D	20 feet.	Alternate strata of sand and clay, with impure lignite and silicified wood in a good state of preservation.
E	100 feet.	Variable bed, consisting of alternations of sand and clay with large concretions containing great numbers of <i>Melania</i> , <i>Paludina</i> , <i>Helix</i> , <i>Planorbis</i> , <i>Cyclas</i> , &c. &c., associated with Saurian remains resembling the <i>Iguanodon</i> and <i>Megalosaurus</i> , <i>Trionyx</i> , &c. &c.
F	25 feet.	Alternations of impure lignite and yellowish-brown clay, the latter containing great numbers of <i>Unio</i> , <i>Paludina</i> , <i>Melania</i> , <i>Cyclas</i> , and the fresh remains referred by Dr. Leidy to the genus <i>Lepidodus</i> .
G	100 feet.	Ferruginous sand and clay, having in upper part a seam 3 or 4 inches in thickness, nearly made up of shells of <i>Unio</i> . Lower part ferruginous, and coarse gray grit, with a seam near the base entirely composed of remains of <i>Unio Danai</i> , <i>U. Dewyi</i> and <i>U. subspatulata</i> .

This section embraces all the deposits, as we believe, seen in the Bad Lands of the Judith, in which land and fresh-water shells are known to occur. They appear, as near as could be ascertained, to occupy a local basin in a series of
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marine deposits, consisting of beds of sandstone and impure lignite, which we have regarded provisionally as of the age of No. 1 of our general section.

Lower down the Missouri, near the mouth of Little Rocky Mountain Creek, this last mentioned series of rocks upon which the fresh-water deposits repose at the mouth of the Judith, is clearly seen to pass beneath No. 4 of the general section; proving that Nos. 2 and 3 are not represented in that part of the country. As no indications were seen in this region of these latter formations, it is probably they are entirely wanting towards the sources of the Missouri.

The deposits above alluded to, (at the mouth of Judith River,) as probably on a parallel with beds seen near the mouth of Big Sioux River on the Missouri,—(forming No. 1, of the Nebraska section,)—are characterized, as stated in one of our former papers, by a group of fossils remarkably distinct from those occurring in any of the higher north western formations; and there remains some doubt as to whether or not they are older than Cretaceous. The presence of the genus *Baculites* would seem to establish the fact that they belong to the Cretaceous epoch; while the occurrence in the same hand specimens with these remains of *Baculites*, of a species of *Hettangia*,—a genus of bivalves, not known to occur in the old world in newer formations than the Lias,—would, on the other hand, indicate that these beds are older than Cretaceous. For the present, however, we express no decided opinion on this point, but content ourselves with the remark, that we are inclined to think they hold a position near the base of the Cretaceous system, and are probably on a parallel with the Neocomien of the old world, though they may be older.

The following section, taken near the mouth of Judith River,* will exhibit approximately the lithological characters, and order of succession of these deposits at that locality. It is not pretended, however, that this section represents all the beds of this series, as others were observed near them, but owing to the distortion and disturbance of the strata, and the unfavorable circumstances under which the observations were made, it was impossible to devote time enough to their examination to collect the means of constructing a connected general section of the whole series. We should also state here that the specimens furnishing the data upon which this section, and that of the fresh-water and estuary deposits near the same locality, were constructed, although collected some time back, only came to hand since the communication of our last paper.

SECTION OF THE OLDER DEPOSITS AT THE MOUTH OF JUDITH RIVER, IN THE DESCENDING ORDER.

- Bed A.—Yellowish and reddish, rather coarse grained sandstone, becoming deep red on exposure,—containing *Inoceramus ventricosus*, *Mastra alta*, *Cardium speciosum*, &c., &c. 20 to 25 ft.
- " B.—Mixed pure and impure lignite—whole bed containing many crystals of selenite, and a yellowish substance like sulphur. The masses of lignite, when broken, reveal in considerable quantities small reddish crystalline fragments of a substance having the taste and appearance of rosin... 6 to 8 ft.
- " C.—Variable strata of drab clay, and gray sand and sandstone:—upper part containing large numbers of *Ostrea glabra*. Near the middle, there are gray or ash-colored clays with very hard bluish gray granular, siliceous concretions, containing *Hettangia Americana*, *Panopcea occidentalis*, *Mastra formosa*, &c., 80 to 100 ft.

At several points near the locality where the above section was taken, the bed G, of the last section, with its characteristic fossils, was seen superimposed upon the bed A, of the section here given; but the line of junction was not sufficiently well exposed to determine very satisfactorily whether the upper part of these lower deposits bears marks of denudation previous to the deposition of the overlying freshwater and estuary beds or not.

On a former occasion we expressed very briefly our views in regard to the parallelism of the Cretaceous formations of Nebraska with those of New Jersey, Alabama, and portions of the far west and south west. In order to make more clear some of these points of parallelism, we here reproduce for comparison, with some modifications, the general section of the Nebraska formations; and

*By Dr. Hayden.

also give sections of the Cretaceous formations as seen in Alabama and New Jersey. For the Alabama section we are indebted to Prof. A. Winchell, of Ann Arbor, Michigan, who has devoted much time to the study of the Cretaceous rocks of the South. Most of the facts given in this section are contained in an interesting paper read by Prof. Winchell, before the American Association for the Advancement of Science, at the last meeting, held in Albany, N. Y. As here given, however, this section has been constructed from information kindly furnished us by Prof. Winchell, in advance of the printing of the Proceedings of that meeting.

The New Jersey section we have compiled from the reports of Prof. Ketchel and Prof. Cook, Geologist and Assistant Geologist of that State. In the instances where the positions of fossils were not given in the reports above alluded to, we have been guided by information kindly furnished by Prof. Cook, in several communications received from him.

Alabama Section, from facts communicated by Prof. A. Winchell.

	Thickness.	SUBDIVISIONS.	Eq. of the Nebraska Section.	Eq. of the N. Jersey Section.
A	4 feet.	Decomposing dark limestone, with obscure casts of shells.	No. 5.	b. or 2d Green Sand.
	6 feet.	Soft white limestone— <i>Gryphæa vesicularis</i> , <i>Exogyra costata</i> , <i>Scaphites Conradi</i> , <i>Nautilus Dekayi</i> , <i>Baculites ovatus</i> , &c. &c. <i>Ammonites lobatus</i> , Tuomey, (here?)		
B	45 feet.	Loose white sand, with <i>Ostrea larva</i> , <i>Pecten 5-costatus</i> , <i>Gryphæa vomer</i> and fragments of fossil wood.	No. 4.	Beds c, d and e.
C	150 feet or more. *	Soft white limestone, ("Rotten limestone,") decomposing above, more argillaceous below, and near the base becoming a firm calcareous sandstone. <i>Inoceramus biformis</i> of gigantic dimensions, <i>Radialites</i> , <i>Nautilus Dekayi</i> , <i>Ammonites Delawareensis</i> , <i>Baculites ovatus</i> , Shark's teeth, and Mosasauroid remains.		
	6 feet.	Gray indurated sand with <i>Gryphæa vesicularis</i> , <i>Exogyra costata</i> , <i>Inoceramus biformis</i> , <i>Pecten 5-costatus</i> , <i>Teredo tibialis</i> , <i>Ammonites placenta</i> , <i>A. Delawareensis</i> , teeth of fishes. &c. &c.		
D	15. feet.	Perfectly loose obliquely laminated sand, of gray and greenish-yellow color, with thin unconformable lamina of dark green sand passing in horizontal planes through the main bed. Much fossil wood, with <i>Teredo tibialis</i> .	No. 1.	Formation f.
E	300 feet, may be much more.	Beds of dark blue soft shale, or indurated clay, alternating with strata and seams of white, and mottled clays, green and ferruginous sand, and dark pyritiferous shale. No organic remains but stems and leaves, of apparently dicotyledonous plants, and a few obscure casts of other fossils. <i>Ceratites Americana</i> , however, of Harper, is supposed to hold a position somewhere in this series.		

* According to Prof. Tuomey this bed sometimes attains a thickness of 1,000 feet.

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NEW JERSEY SECTION COMPILED FROM THE REPORTS OF THAT STATE.

a.	3d bed. G. Sand.	Green Sand.	60 ft.	Tertiary. No. 5 Nebras.
		"The sand between the second and third beds has usually been confounded with beach sand, which it closely resembles." 45 or 50 ft.		
b.	2d bed. G. Sand.	Yellow limestone.		Represents No. 4 Nebraska
		Green Sand, <i>Scaphites Conradi</i> , <i>Baculites ovatus</i> , <i>Ammonites placenta</i> . 45 or 50 ft.		
c.		Sand "much colored with oxyd of iron, and when sufficiently firm is found almost full of the impressions of shells." <i>Belemnites mucronatus</i> . 65 or 70 ft.		Represents No. 1 of the Nebraska section
d.	1st bed. G. Sand.	Green Sand, <i>Nautilus Dekayi</i> , <i>Baculites ovatus</i> , <i>Belemnites mucronatus</i> , and bones of <i>Mosasaurus</i> . 50 ft.		
e.		Dark clays with "occasional streaks and irregular spots of green sand." <i>Ammonites placenta</i> , <i>Baculites ovatus</i> , &c. &c. 130 ft.		Represents No. 1 of the Nebraska section
f.		Dark blue, ash colored, and whitish clays, and micaceous sand, with thin seams of coal. Great quantities of sulphuret of iron "Fossil wood is found in some of the layers in large quantities, and some very distinct impressions of net-veined leaves were examined in the clay at French's landing." 130 ft. or more.		

By comparing the foregoing sections with the following general section of the Nebraska rocks, the parallelism between the formations, so far as the Cretaceous rocks of the North West are represented in Alabama and New Jersey, will be at once understood.

In the following section of Nebraska rocks it will be observed we have placed together all the Tertiary deposits known to us, without intending to express any opinion in regard to the comparative ages of these formations. We have also written in the column opposite them the word "Miocene;" this, so far as the Judith River fresh water and Estuary formations are concerned, is done provisionally. We have likewise made three subdivisions of formation No. 3. This latter change is made mainly upon lithological differences between what we regard as probably subordinate members of the same formation. The upper or dark bed of very fine argillaceous matter, passes both downwards, and at some points, horizontally into the gray marl below it, and appears to be local, while the gray marl, in its turn, passes imperceptibly into the light colored limestone below.

It is due to the lamented Mr. Nicollet that we should state here, he saw the two beds above mentioned, and noticed their differences in his report; but in consequence of the fact that he referred the *Inoceramus* occurring in the limestone (*I. problematicus*) to *I. Barabini*, a fossil not known below No. 4 and 5 of the section, if indeed it occurs at all in the Nebraska beds, we were always at a loss to understand his section. In addition to this, neither of us had ever visited localities where this bed or the dark deposit forming the upper part of No. 3 is exposed, previous to the late explorations.

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Vertical Section of the Geological Formations of Nebraska Territory, so far as determined.

SUBDIVISIONS.		LOCALITIES.	Estimated thickness.	
TERTIARY SYSTEM.	MIocene.	Light colored indurated clays, with occasional beds of sandstone, conglomerate and whitish limestone. Great numbers of <i>mammalian</i> and <i>chelonian</i> remains, with a few fresh-water and land shells.—(Bad Lands of White River.) Beds of clay, sand, sandstone, and lignite, containing great numbers of fresh-water and land <i>mollusca</i> , with a few marine or estuary shells; remains of plants, <i>Saurians</i> , <i>Trionyx</i> , &c. &c.—(Great Lignite Basin.) Sand, sandstone, clays, and very impure lignite, with remains of fresh-water, land, and a few estuary shell, <i>Saurians</i> , fishes, <i>Trionyx</i> , &c.—(Bad Lands of Judith.)	<i>Mauvaises Terres</i> of White River. Great extent of country on both sides of the Missouri between Heart and Milk Rivers; on the Yellow Stone. Bad Land at the mouth of Judith River, &c. &c.	About 900? feet.
	No. 5.	Gray and yellowish arenaceous clays, and sandstones, sometimes weathering to a pink color; containing <i>Belemnites bulbosa</i> , <i>Nautilus Dekayi</i> , <i>Ammonites placenta</i> , <i>A. lobatus</i> , <i>Scaphites Conradi</i> , <i>Baculites ovatus</i> , and great numbers of other marine mollusca.	Moreau trading post, and under the Tertiary at Sage and Bear Creeks. Fox Hills.	100 to 150 feet.
CRETACEOUS SYSTEM.	No. 4.	Bluish and dark gray plastic clays, containing <i>Nautilus Dekayi</i> , <i>Ammonites placenta</i> , <i>Baculites ovatus</i> , and <i>B. compressus</i> , with numerous other marine mollusca,—remains of <i>Mosasaurus</i> .	Great area about Fort Pierre and along the Missouri below there. Under No. 5, at Sage and Bear Creeks. Great Bend of the Missouri. Near Milk and Muscle shell Rivers.	350 feet.
	No. 3.	20 ft. Dark, very fine unctuous clay, containing much carbonaceous matter, with veins and seams selenium, sulphuret of iron, fish and scales, (local.)	Bluffs along the Missouri, below the Great Bend. Extends to Big Sioux River, and occurs along the latter stream.	150 feet. N. Jersey & Alabama.
		100 ft. Lead gray calcareous marl, weathering above to a yellowish tint. Scales and other remains of fishes— <i>Ostrea congesta</i> —passing downwards into		
		30 ft. Light gray or yellowish limestone, containing great numbers of <i>Inoceramus problematicus</i> , fish scales, and <i>Ostrea congesta</i> .		
	No. 2.	Dark gray laminated clay scales and other remains of fishes, small Ammonites, <i>Inoceramus problematicus</i> ?, <i>Serpula</i> , small oyster-like <i>O. congesta</i> , &c. &c.	Along the Missouri Bluffs, from ten miles above James River to Big Sioux River.	90 feet. Wanting in
No. 1.	Yellowish and reddish friable sandstone, with alternations of dark and whitish clays. Seams and beds of impure lignite, fossil wood, impressions of dicotyledonous leaves; <i>Solen</i> , <i>Pectunculus</i> , <i>Cypriina</i> , &c. This bed is not positively known to belong to the Cretaceous system.	Near the mouth of Big Sioux River, and between there and Council Bluffs. Near Judith River?	90 to 100 feet, or more.	
CARBONIF. SYSTEM.		Yellow limestone, containing <i>Fusulina cylindrica</i> , <i>Terebratula subtilita</i> , <i>Spirifer Meusebachianus</i> , <i>Altorisma regularis</i> , and other fossils of the coal measures.	Forms shoals in the Missouri River at De Soto; 15 to 20 feet exposed at Council Bluffs, at low stages of the river.	Unknown.

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The position and vertical range of such fossils as are known to be common to the North West and New Jersey, in the foregoing general section of the Nebraska rocks, clearly establishes, as stated in our paper communicated to the Academy in November last, that formations No. 4 and 5 of the North West, are on a parallel with the beds b. c. d. and e. of the New Jersey series.

After a careful review of the subject, we are now satisfied that the parallelism of these beds may be more closely drawn, or in other words, that the second green sand bed of the New Jersey section represents No. 5 of Nebraska, and that No. 4 of the latter region is on a parallel with the beds c. d. and e. of New Jersey.

At the same time the identity of No. 1 of the North West, with the beds composing f. of the New Jersey section, is scarcely less apparent. It is true this latter opinion rests mainly upon stratigraphical and lithological evidence, yet these points of analogy are so strong as to possess great weight. In order that this may be better understood and appreciated, we quote below from notes taken by one of us* in 1855, a description of an exposure of No. 1 seen on Big Sioux River, which will show, by comparison with the New Jersey section, the striking resemblance between the beds holding a position at the base of the Cretaceous formations at these distantly separated localities.

"Six miles above the mouth of Big Sioux River we have an exposure of impure lignite about 12 inches in thickness, underlaid by alternate layers of sandstone, loose clay, yellow and ash colored arenaceous clays, and fine whitish clay. The strata containing clay have quite distinct impressions of leaves, which appear to have belonged to dicotyledonous trees. We have also, near the base of the exposure, some fine impressions of leaves in dark tough gray, siliceous, concretionary rock. Much pyrites and fragments of fossil wood occur in these beds."

The points of analogy between these lower deposits (No. 1) of the north-west, and formation f at the base of the New Jersey section, as well as with an extensive series of deposits holding the same position in Alabama, (formation E of the Alabama section,) and throughout a great area of country in Arkansas, Texas, and New Mexico, will be more fully illustrated by the following section taken in north-eastern Kansas, where this series appears to be more extensively developed than at any localities known to us in Nebraska.

For this section, as well as much other interesting and important information respecting the geology of the country surveyed by him, we are indebted to the kindness of Major F. Hawn, formerly of the geological survey of Missouri, but now connected with the lineal survey of portions of Kansas Territory. We give it exactly as communicated to us by him, excepting that we have thrown it into a tabular form, and added columns showing the parallelism of the beds with those of New Jersey and Nebraska. To those acquainted with Major Hawn, it is unnecessary for us to say he is a careful conscientious observer, whose statements are worthy of the fullest confidence.

The beds represented in this section were not all seen at any one locality, but their thickness, composition and order of succession were determined from examinations made at numerous exposures in the country east of the sixth principal meridian, between the northern boundary of Kansas and the Republican fork of Kansas River.

* Dr. Hayden.

Sections of the rocks in North Eastern Kansas, (above the coal measures).

By MAJOR F. HAWN, U. S. Dep. Surveyor.

		SUBDIVISIONS.		Eq. Nebraska section.	Eq. New Jersey section.	Eq. Alabama section.
	Thickness.					
a.	45 feet.	Light gray limestone with <i>Inoceramus problematicus</i> and other Cretaceous fossils.		No. 3. (lower part.)	Wanting in New Jersey.	Wanting.
b.	27 feet.	Slope strewn with light gray calcareous concretions.		No. 2?	Wanting in New Jersey.	Wanting.
c.	25 feet.	Hard concretionary dark ferruginous sandstone, containing fossil wood, and impressions of leaves resembling those of the common willow.		Jurassic of Mr. Marcon.		
d.	90 feet.	Slope with numerous large rounded blocks thinly laminated sandstone.				
e.	10 feet.	White very fine grained soft calcareous sandstone.				
f.	8 ft.	Soft thinly laminated dark blue clay.				
g.	12 feet.	White clay, stained in spots with oxyd of iron.				
h.	28 feet.	Slope with large irregular blocks of hard dark ferruginous sandstone, containing large quantities of fossil wood and leaves, like those of <i>Quercus alba</i> .		Triassic of Mr. Marcon.		
i.	50 feet.	Soft coarse buff sandstone, rapidly disintegrating where exposed.				
j.	30 feet.	Light blue clay.				
k.	14 feet.	Slope strewn with rectangular blocks soft, dark brown, fine grained sandstone.				
l.	60 feet.	Slope, upper part covered by loose flags of dark ferruginous conglomerate, composed of coarse sand and small silicious pebbles.				
m.	48 feet.	Light gray and buff irregularly stratified silicious limestone, probably of Carboniferous age.		Formation E.		

The similarity between the beds from c. to l. inclusive, of the above section, and formation f. of the New Jersey series, when taken in connection with their position in relation to the higher formations, is too obvious to leave much room to doubt that they belong to the same horizon.

Mr. Henry Pratten, of the Geological Survey of Illinois, to whose liberality we are indebted for a full abstract of notes taken by him on the geology of the country along the California trail between Fort Leavenworth and San Francisco, informs us that he met with the lower members of the Nebraska section at several points along Platte River, above Fort Laramie. No. 1, he says, as in portions of north-eastern Kansas, and on the Missouri below the Big Sioux, reposes directly

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upon upper Carboniferous strata, and presents its usual characters, excepting that the beds of sandstone are more frequently white. He did not see No. 2 well exposed, its place in the series being usually occupied by a slope. Above this, however, he saw the lower beds of No. 3, presenting their usual lithological characters, and containing the fossil everywhere marking this horizon, (*Inoceramus problematicus*.)*

Mr. Hawn writes us, he has been informed by an intelligent Deputy Surveyor, that the formations represented in his section, especially the beds below the upper limestone, were seen by him at intervals along the sixth principal meridian, as far south as his survey extended, or to the fifth standard parallel, near the Arkansas River.

Exactly similar deposits were observed by Dr. George B. Shumard in the vicinity of Fort Washita, and the Cross Timbers in northern Texas. He describes these formations as consisting of "grayish yellow sandstone, with intercalations of blue, yellow and ash colored clays, and beds of white and bluish-white limestone. The limestone reposing on the clays and sandstones." (See Capt. Marcy's report of Explorations on Red River, page 181.)

In one of the upper beds of this series Dr. Shumard found, along with several new species of Cretaceous fossils, some of the same shells collected by Dr. Roemer from similar deposits at New Braunfels, and other localities further south in Texas. He likewise collected from the same beds, species identical with some of those found in the same position by Mr. Marcou at Pyramid Mountain, in New Mexico, thus establishing the parallelism of the formations at all these localities.†

A section of these deposits taken by Mr. Marcou at Pyramid Mountain, near the Llano Estacado, (Bulletin Geol. Soc. France, Tome 12, p. 878), corresponds remarkably in its general features with Mr. Hawn's section already given, of these formations in north-eastern Kansas. The identity of composition and order of succession of the various beds represented in these sections, can scarcely be due to accident, but points rather to the conclusion that they were deposited at the same time in the same ocean.

For the sake of comparison we give below, in a tabular form, Mr. Marcou's section of Pyramid Mountain, with columns showing the parallelism of the various beds with the formations in Nebraska, Kansas, New Jersey and Alabama, as well as his views respecting the parallelism of the same with formations of the Old World.

* Since these remarks were written, I have received with deep regret the sad news of Mr. Pratten's death. In making this announcement, it affords me a melancholy pleasure to bear witness to his merits as a man and a devoted cultivator of natural science. Along with all the artless simplicity of a child, he possessed an intellect of no ordinary powers; while his studious habits and untiring perseverance, aided by a wonderful memory, had enabled him, under circumstances far from propitious, to acquire an amount of knowledge in various departments of science, of which the most favored might be proud. Perhaps no person now living possesses a better knowledge of the western carboniferous fossils than he did; and yet this was only one of several branches of science to which he had devoted many years of his life. His quiet habits and unpretending manners, however, had to a great extent prevented his real merits from being duly appreciated outside of a comparatively limited circle of personal acquaintances. With all, and better than all, his other qualities of head and heart, Mr. Pratten was a high minded, honorable man.

F. B. M.

† I am under obligations to Dr. B. F. Shumard for a few specimens of fossils collected by his brother from these formations in Texas.

F. B. M.

Section of the Formations at Pyramid Mountain, New Mexico.

	Thickness.	SUBDIVISIONS.	Eq. Nebraska Section.	Eq. N. Jersey Section.	Eq. Alabama Section.
a	5 or 6 ft.	White, very compact silicious limestone.	No. 3, lower.	Wanting in N. J.	Wanting.
	5 or 6 ft.	Hard, deep yellow gritty limestone.			
b	30 feet.	Bluish-gray clay of subschistose structure, containing near the base a species of <i>Gryphaea</i> and <i>Ostrea</i> , (referred by Mr. Marcou to <i>G. dilatata</i> and <i>O. Marshii</i> .)	No. 2.		
c	25 feet.	Fine grained, white sandstone, disintegrating rapidly where exposed.	JURASSIC OF MR. MARCOU.		
d	80 feet.	Hard, fine grained sandstone of a light yellow color, forming perpendicular escarpments.			
e	8 feet.	White, fine grained sandstone.			
f	200 ft.	Alternations of red, green and white marly clays.	TRIASSIC OF MR. MARCOU.		
			NUMBER 1.	FORMATION F.	FORMATION E.

Mr. Marcou does not mention the occurrence of *Inoceramus problematicus* in the limestone (a) of his section at this locality, but it has been found in this position at various localities in the south-west by others, as stated in our last communication. From the facts given by him, there is also scarcely room for a doubt, but the specimen of *Ostrea congesta*, we mentioned seeing in his collection† (Proceed. Acad. Nat. Sci. November last) from Galisteo, was either found in this bed or the clays immediately below it, (b of his section,) in both of which deposits it occurs in Nebraska.

As Pyramid Mountain is but an isolated portion, left by the denudation of the surrounding strata, of a great elevated plateau known as the *Llano Estacado*, which occupies a vast area of country in western Texas and New Mexico, it is highly probable the beds composing Mr. Marcou's section are widely distributed

*We think these identical with species found by Dr. George B. Shumard at Fort Washita, Texas, where they appear to hold the same geological position, and are associated with *Ammonites vespertinus* (Morton.) Dr. B. F. Shumard has correctly, as we believe, referred the first to *Gryphaea Pitcheri* (Morton), and described the latter as a new species, under the name of *Ostrea subovata*. (See Capt. Marcy's Report Explorations Red River, page 205—Appendix.) We are almost willing to hazard the opinion, that these species will yet be found in Southern Nebraska, or north-eastern Kansas, in formation No. 2 of the Nebraska Section.

† In alluding to this fact in our last paper, we inadvertently omitted to mention that the specimen seen by us is in the possession of Prof. Hall, by whose permission we referred to its occurrence at that locality.

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over the far south-west. This conclusion is also borne out by the statements of Capt. Marcy and other explorers of that region. The facts given by this gentleman and Dr. G. G. Shumard, likewise point to the conclusion that the great gypsum deposits of the south-west hold a position equivalent to No. 2, or the upper part of No. 1 of the Nebraska section.

From all the facts, we are led to believe, as stated on a former occasion, that the divisions No. 4 and 5 of Nebraska, and their equivalents in New Jersey and Alabama, are entirely wanting, or but meagrely represented, throughout the south-west; and that No. 2 and No. 3 are the main fossil-bearing strata of that region; while No. 1, which there as in the north-west and in Alabama, reposes on Carboniferous strata, attains a much greater development than in either of those countries.

CONCLUSIONS.

1st. We have no evidence that any of the Tertiary deposits now known in Nebraska are older than Miocene.

2d. The estuary and fresh-water deposits at the mouth of Judith River are probably on a parallel with the lowest bed of the Great Lignite basin, though some portions of them may be somewhat older.

3d. The Great Lignite basin and the *Mauvaises Terres* of White River, though probably both Miocene, are not exactly on a parallel.

4th. We have in Nebraska a more complete series of Cretaceous formations, and consequently a better standard of comparison for rocks of that age, than is yet known to exist in any other portion of this country.

5th. The formations in New Jersey and Alabama generally referred to the Cretaceous system, are on a parallel with the *upper* and lower members of the Nebraska section, (No. 1, 4 and 5;) while nearly, if not quite all the main fossil-bearing deposits older than Tertiary, and newer than Carboniferous, in Kansas, Arkansas, Texas and New Mexico, are on a parallel with the *middle* and lower portions of the same.

6th. Although the beds No. 2 and 3 of the north-west, are extensively developed, and probably the principal fossiliferous Cretaceous deposits of the far south-west, we have up to this time, no evidence of their existence east of the Mississippi. Consequently the marked typical differences observable between most of the Cretaceous fossils hitherto found in the south-west, and those characterizing the upper Cretaceous formations of Nebraska, Alabama and New Jersey, are not wholly due to the fact that they belonged to different zoological districts; nor yet, as might be supposed in regard to the Nebraska and New Jersey species, to the modifying effects of physical conditions dependent on latitude; but mainly to the fact that they belong to another geological horizon, and consequently lived during a different epoch.

7th. There is at the base of the Cretaceous System, at distantly separated localities in Nebraska, Kansas, Arkansas, Texas, New Mexico, Alabama and New Jersey, if not indeed everywhere in North America where that System is well developed (at any rate east of the Rocky Mountains), a series of various colored clays and sandstones, and beds of sand, often of great thickness, in which organic remains, excepting leaves of apparently dicotyledonous plants, fossil wood, and obscure casts of shells, are very rarely found, but which everywhere preserves a uniformity of lithological and other characters, pointing unmistakably to a similarity of physical conditions during their deposition, over immense areas.

8th. Although the weight of evidence thus far favors the conclusion that this lower series is of the age of the lower Green Sand, or Neocomien, of the old world, we yet want *positive* evidence that portions of it may not be older than any part of the Cretaceous System.

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DESCRIPTIONS OF NEW FOSSILS.*

PTYCHOCERAS MORTONI.

Shell small and thin, elongate cylindrical; larger half, or body, very slightly tapering, apparently rounded on the dorsum, and concave along the inner side for the reception of the slender smaller half. Surface ornamented by rather strong annular costæ, which are less prominent, and somewhat irregularly divided on the body, and bifurcate occasionally on the smaller part; dorsum of the slender half ornamented by two rows of very small nodes, arranged upon the costæ; fine indistinct lines of growth mark the shell parallel to the ribs. Aperture, septa, and siphuncle unknown. Length (of specimen imperfect at the aperture, and apex of smaller portion) about 1 inch; breadth .26 inch; diameter of slender part .12 inch; do. of body .17 inch.

This shell is about the size, and has much the general appearance of a species described by Dr. Morton from the deep cut of the Chesapeake and Delaware canal, under the name of *Hamites annulifer* (Jour. Acad. Nat. Sci. vol. 8, pl. xi. fig. 4,) but differs from his figure in having bifurcating instead of simple costæ. It is possible, however, that they may not be distinct, though it is hardly probable so important a character as the bifurcation of the costæ would have escaped the attention of so close an observer as Dr. Morton.

Judging from the nodes seen along the dorsum of the smaller portion of our shell, it appears probable similar or stronger nodes may have existed along the outside of the body, or larger half; if so, it must have differed materially in this respect from Dr. Morton's species. When entire our specimen must have been not less than $1\frac{1}{2}$ to 2 inches in length.

Dedicated to the lamented Dr. George Morton of Philadelphia.

Locality and position. Great bend of the Missouri, formation No. 4. of the series.

SERPULA? TENUICARINATUS.

Shell growing in groups, or rarely single, slightly compressed-cylindrical, increasing very gradually in size, irregularly curved or flexuous, not spirally coiled; attached by one side nearly the whole length; having a distinctly elevated, linear carina along the upper side; surface sometimes very obscurely undulating transversely, otherwise smooth. Length unknown; transverse diameter about .14 inch.

As we have no perfect specimens of this fossil, it is with some doubt we refer it to the genus *Serpula*. It appears to have no internal septa as in *Vermetus*; and we have seen no indications of an operculum as in *Vermicularia*; consequently we place it provisionally in the genus *Serpula*.

Locality and position.—Mouth of Vermillion River, on the Missouri, formation No. 2 of the series.

VITRINA OBLIQUA.

Shell obliquely oval; spire much depressed; volutions four to four and a half, first two or three increasing rather slowly in size, last one ventricose and rapidly enlarging, prominent below; suture distinct; aperture circular; surface unknown. Greatest transverse diameter .64 inch; height .50; diameter of aperture .37 inch.

Having seen only internal casts of this shell, we are in some doubt about its generic relations; as its associates, however, belong to land and freshwater genera, and its form agrees very nearly with that of *Vitrina*, we place it provisionally in that genus. It resembles a species described by Reuss and Von Meyer, under the name of *V. intermedia* from the Tertiary Lacustrine deposits in the north of Bohemia, (see Tert. Süß. pl. 1 fig.) but has more volutions.

Locality and position. Mouth Judith River, bed E of the section of freshwater and estuary deposits at that place.

* Illustrations to be published hereafter in Lieut. Warren's Report.

HELIX OCCIDENTALIS.

Shell thin, rather small, depressed nearly orbicular; volutions four, convex above, prominent, or almost subangular a little above the middle of the outside, gibbous below, most convex near the umbilicus; surface ornamented by regular rather strong oblique lines of growth; suture well defined; umbilicus deep, less than one third the transverse diameter of the shell, exhibiting most of the inner volutions; aperture round oval, modified slightly by the succeeding whorl; lip sharp, not reflexed. Greatest transverse diameter .33 inch; height .21 inch; greatest diameter of aperture .16 inch.

This neat little *Helix* is more nearly related to the recent *H. striatella* of Anthony than to any other shell we have seen figured, but is larger, has a smaller umbilicus, and appears to be more strongly striated. Mr. Anthony says the umbilicus of *H. striatella* is not equal to the body whorl. In the species before us, it is scarcely half equal to the body volution near the aperture.

Locality and position. Same as last.

HELIX VITRINOIDES.

Shell subglobose; spire elevated; volutions about four, convex, increasing rather rapidly, last one somewhat ventricose, contracted a little near the lip; suture distinct; umbilicus very small or closed; aperture oval or ovate; (lip reflexed?); surface unknown. Height .37 inch; breadth .44 inch; greater diameter of aperture .27 inch; smaller do. .20 inch.

Of this species we have only seen internal casts, and consequently know nothing of its surface markings. Judging from the slight contraction of the body whorl of the cast near the aperture, it is probable the lip was thickened and reflexed.

Locality and position. Same as last.

PLANORBIS TENUIVOLVIS.

Shell planiorbicular; spire flat or nearly so; volutions six to six and a half, extremely narrow and closely embracing; increasing very gradually, scarcely one-third as broad as high, rounded above, prominent, or almost subangular round the outer margin, from which they round obliquely downwards and inwards towards the umbilicus, near which they are more prominent or subangular; suture well defined; umbilicus deep, acutely conical; equaling about one-third the greater diameter of the shell, and exhibiting the volutions quite to the apex of the spire; surface and aperture unknown; section of volutions extremely narrow and strongly arcuate. Greater diameter .15 inch; height .06 inch.

This remarkably delicate little shell resembles the following species (*P. amplexus*) more than any with which we are acquainted; it differs, however, in having much narrower and more closely wound volutions; about the same number being present in specimens measuring not much more than one-third the transverse diameter of that shell.

Locality and position. Same as last.

PLANORBIS AMPLEXUS.

Shell planorbicular; spire flat, or nearly so; volutions six, closely embracing, narrow, very gradually increasing, nearly twice as high as wide, rounded on the outside, subangular round the umbilicus; surface marked by lines of growth, which pass round very obliquely backwards from above to a point below the middle of the outer part of the whorls, where they are again directed slightly forwards, so as to indicate the presence of a broad, undefined sinus, below the middle of the outer lip; aperture unknown, umbilicus conical, deep, less than half the greater diameter of the shell, exhibiting the inner whorls. Greatest diameter .39 inch; height .25 inch.

This species bears some resemblance to our *P. convolutus* (Proceedings Acad. Nat. Sci. vol. 8, p. 120,) but has from one to one and a half more volutions, which 1857.]

are much narrower and more embracing. The spire also differs in being flat instead of convex, as in *P. convolutus*, and the umbilicus is much deeper, narrower and more defined in the species before us.

Locality and position. Bed C of the section of freshwater and estuary deposits at mouth of Judith River.

PLANORBIS FRAGILIS.

Shell rather large, very thin, nearly planiorbicular; (spire much depressed or flattened?); umbilicus large, deep and exhibiting all the whorls to the apex of the spire; volutions five or six, (much depressed or flat above?) prominent below, rounded on the lower outer side, subangular round the margins of the umbilicus; (periphery angular?); surface marked by rather faint lines of growth. Greatest diameter 1.23 inches; height about .40 inch.

As we have seen only imperfect specimens of this shell, we think the above description may have to be modified somewhat when better specimens are obtained. In those we have seen, the volutions appear to have been nearly flat or much depressed above, in consequence of which the outer side of the whorls is distinctly angular. This character, however, and the remarkable flatness of the spire, may be, at least to some extent, caused by pressure.

Locality and position.—Fort Berthold on the Missouri River, in Lignite Tertiary basin.

MELANIA SUBTORTUOSA.

Shell conical screw-shaped; spire not much elevated; volutions about five, very convex, distinctly angular round the middle, increasing rather rapidly from the apex; suture strongly defined, in consequence of the prominence of the angular whorls; surface and aperture unknown. Length 29 inch; breadth .21 inch; apical angle regular, divergence 47°.

The angular form of the whorls is so conspicuous a character in this species, that it will be at once known from all its associates, and indeed from all the Nebraska species we have seen, by this character alone. It bears considerable resemblance to *M. tortuosa* of Anthony, (An. Lyc. Nat. Hist., N. Y. vol. 6,) a recent species, but has a shorter spire, and not so many volutions. It is, perhaps, nearer in form to *M. acuto-carinata* of Lea, but may be distinguished by its more distinctly angular body whorl; the angle on Mr. Lea's species being only well defined on the spire.

Locality and position. Mouth Judith River, bed C. of the section of freshwater and estuary deposits at that place.

MELANIA OMITTA.

Shell small, very slender; spire elongate conical, acute at the apex; volutions about seven, flattened, or very slightly convex, increasing very gradually from the apex; suture linear, not deeply impressed; surface and aperture unknown. Length .42 inch; breadth .12; apical angle regular, divergence 23°.

Although we have seen neither the aperture nor surface markings of this little shell, we have ventured to characterize it, believing its slender form alone will serve to distinguish it from any of the other species with which it is associated.

Locality and position. Mouth Judith River, in layer of pebbly sandstone of bed G? of the fresh-water and estuary deposits at that place.

MELANIA SUBLEVUS.

Shell elongate conical; spire elevated (acute at the apex?); volutions (about seven?) very depressed convex; suture rather distinctly defined; surface apparently smooth, but when examined with a lens is seen to be marked by fine obscure lines of growth, crossed by extremely fine, nearly obsolete revolving striae; aperture ovate, angular above; columella and outer lip nearly equally

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arcuate; pillar faintly sinuous below. Length about 1.04 inch; breadth .38 inch; apical angle slightly concave, divergence 24° .

This species will be known from all the others we have seen in the Nebraska formations, by its slender spire, and slightly concave sides. It is also proportionally longer than any Nebraska species known to us, excepting our *M. convexa*, (Proceedings of the Acad. Nat. Sci. vol. 8, p. 125,) from which it may be at once distinguished by its depressed convex, instead of flat, volutions, more defined suture, finer revolving lines, and more slender spire. Unfortunately none of our specimens are quite perfect enough to show the number of volutions; one specimen consists of five turns of the spire, and, judging from the appearance of the broken apex, there were probably about two more.

Locality and position. Bad lands of Judith River, bed G. of Fresh-water and Estuary formations at that place.

MELANIA INVENUSTA.

Shell conical ovate; spire moderately elevated; volutions about seven, very slightly convex, increasing rather slowly from the apex; suture linear, not much impressed; surface marked by obscure lines of growth crossed by fine irregular rather indistinct revolving lines, a few of which, just below the suture, are larger than the others; aperture ovate; outer lip faintly sinuate above, rather prominent below the middle inner lip reflexed upon the imperforate columella, at the base of which it is broadly sinuous. Length .90 inch; breadth .37 inch; apical angle regular or a little convex, divergence 32° .

This shell is nearer our *M. Nebrascensis*, (Proceedings of Acad. Nat. Sci. vol. 8, p. 124,) than any of the Nebraska species known to us, but has about one more volution, and is uniformly more slender, the body volution being proportionally much smaller. From *M. sublaevus* of this paper and any of the varieties of our *M. convexa* with which it is associated, it may be known by its much less elongate form, and more obscure surface markings. It appears to be about intermediate between our *M. convexa* and *M. Nebrascensis*, but quite distinct from both.

Locality and position. Bad Lands of Judith River, bed A. of the section of fresh-water estuary strata at that place.

MELANIA WARRENANA.

Shell small, somewhat acutely conical; spire rather elevated, pointed at the apex; volutions about seven and a half, depressed convex, closely wound and increasing gradually from the apex, last one sub-angular round the middle; suture distinct; surface apparently smooth, or only marked by very faint lines of growth; aperture broad ovate, obtusely angular above; outer lip very faintly and broadly sinuate above; columella arcuate, rather faintly sinuate below. Length .29 inch; breadth .14 inch; apical angle convex, divergence 32° .

This neat little shell is nearer our *M. Anthonyi*, (Proceed. Acad. Nat. Sci. vol. 8, p. 124,) than any other species with which we are acquainted, but is larger, and its spire more elevated. It has about one and a half to two more volutions than *M. Anthonyi*; also the body whorl is comparatively smaller, and the apical angle nine or ten degrees less. We dedicate it to Lieut. G. K. Warren, of the U. S. Top. Engs., who discovered the only specimen we have seen.

Locality and position. Summit of Square Butte, thirty miles below Fort Clark, on the Missouri, in a gray sandstone—an outlier of one of the lower strata of the Lignite Tertiary basin, where it is associated with *Corbula mactriformis*, *Melania Nebrascensis*, and *M. Conradi*?

MELANIA TENUICARINATA.

Shell ovate conical; spire turreted, not very much elevated, pointed at the apex; volutions six, convex, obliquely flattened above; suture well-defined, in consequence of the prominence of the whorls; surface ornamented by fine regular lines of growth, crossed near the middle of the volutions by from two

1857.]

to about four distinctly elevated, revolving lines, which become obsolete near the apex of the spire; the upper of these lines is larger than the others, and forms a well-marked keel, while the entire surface, above and below them, is marked by smaller, irregular, revolving lines, which, with the lines of growth, form a very fine indistinct cancellated style of ornament; aperture oval ovate, obtusely angular above; outer lip rather sharp, prominent a little below the middle, very faintly sinuous above; columella forming a gentle curve, scarcely sinuate below, not perforate. Length .54 inch; breadth .29 inch; apical angle convex, divergence variable with age, averaging about 45° .

In some of its varieties this species approaches our *M. Nebrascensis*, (Proceedings Acad. Nat. Sci. Phila., vol. 8, p. 124,) but has much more convex volutions, and greatly stronger revolving lines or keels, on the middle of the whorls.

At the time we described *M. Nebrascensis*, we had but few specimens, and those very imperfect; along with these there were one or two specimens of the species now before us, which we were then inclined to regard as only a variety of *M. Nebrascensis*. The collection now in our possession shows, however, that they are distinct, consequently it will be necessary to modify somewhat our description of *M. Nebrascensis*, so as to include only those shells with flattened or depressed convex whorls, and revolving lines, a few of which are larger than others on the middle of the volutions, but never becoming distinct angles or carinæ.

Locality and position. Fort Union, Lignite Tertiary formations.

MELANIA CONVEXA, (M. and H.)

Proceedings of Acad. Nat. Sci. Phila., Vol. 8, p. 125.

From the same locality and position as the above, we find amongst some of the late collections specimens presenting differences from that shell, which we suspect may be of specific importance; we are unwilling, however, without more individuals for comparison, to run the risk of multiplying synonyms by attempting to characterize it as a distinct species. It is a more slender shell than *M. convexa*, the lower volutions are more rounded, and the suture much more distinctly impressed, especially between the lower whorls. For the present we will designate this form as *Melania convexa*, var. *impressa*, and in case further comparisons prove it to be a distinct species, it may be designated by the latter name.

FUSUS VAUGHANI.

Shell fusiform, rather thick; volutions six to six and a half, convex, obliquely a little flattened or concave above, last one narrowing somewhat abruptly below into the (short?) canal; ornamented by small regular vertical folds, which are crossed by prominent revolving bands, less than the spaces between, so as to give the surface a coarsely cancellated aspect; of these bands about four on the body volution, and two on those of the spire are larger than the others, and form indistinct nodes, where they cross the vertical folds. Below these four larger bands on the body whorl, there are about five or six other smaller and more oblique bands, which diminish in size from above; while on the upper obliquely flattened, or concave part of the same whorls, as well as on those of the spire, there are about four much smaller revolving bands or lines. Entire surface marked by distinct lines of growth, which are crossed by fine rather obscure revolving striæ, so as to produce, independent of the larger ornaments above mentioned, a fine reticulated style of marking. Aperture narrow ovate or oval; outer lip bevelled; inner lip thin, folded upon the arcuate and tortuous columella. Length about 1.43 inches; breadth .75 inch; apical angle convex, divergence about 54° .

This species is quite unlike any of those we have hitherto seen from the Nebraska formations. Although apparently occurring in the same bed with well marked Cretaceous forms, it is, like many of the upper Cretaceous species already described by us from this region, very nearly allied to forms belonging to the

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Tertiary system of the old world. One of these, *F. rarisulcatus* of Deshayes, (Coq. Fos. p. 556, pl. 76, figs. 32, 34,) resembles it very closely in form and surface characters, but differs in having the outer lip distinctly crenulated within.

The specific name is given in honor of Col. A. J. Vaughan, Indian Agent for the Upper Missouri country, to whose patronage we are indebted for many of the Nebraska species heretofore described by us.

Locality and position. Near mouth of Heart River, junction of Upper Cretaceous and Tertiary beds.

FUSUS SUBTURRITUS.

Shell fusiform; spire conical, turreted, very acute at the apex; volutions about seven and a half, obliquely flattened or a little concave above, convex, and ornamented round the middle by a single row of rather prominent nodes, which on the upper whorls are prolonged so as to form more or less distinct vertical folds, last one tapering rather obliquely into the straight canal; surface ornamented by fine lines of growth, which are crossed by small rather regular elevated thread-like lines, about equalling the spaces between; suture linear, and when viewed from above is seen to deviate from a regular curve in following the undulating outline of the prolonged nodes: aperture obovate, narrowing below into the canal. Length about 1.73 inches; breadth .90 inch; apical angle nearly regular, divergence 55°.

This species is more nearly related to our *F. Newberryi* (Proceed. Acad. Nat. Sc. Philada. vol. 8, p. 66) than any shell we have seen, but differs in having a more elevated spire, which is much more acute at the apex; it also has from two to two and a half more volutions than *F. Newberryi*, and much more prominent nodes.

Locality and position. Upper part of No. 4, near Grand River.

FUSUS INTERTEXTUS.

Shell fusiform, or elongate rhomboidal, rather thick; spire conical, moderately elevated; volutions about six, convex below, sloping very obliquely, and concave above, ornamented round the middle by a regular row of vertically elongated nodes; last whorl tapering rather gradually into the canal; suture not very distinct; surface ornamented by well marked lines of growth, which are crossed by strong, elevated, revolving lines, less than the spaces between on the middle and upper portions of the whorls, but smaller, more crowded, and sometimes alternating in size, below the middle of the last turn; aperture narrow obovate, obtusely angular above, narrowing gradually below; margin of outer lip sharp or bevelled, prominent in the middle, retreating above and below; inner lip scarcely distinct from the slightly arcuate columella. Length about 1.87 inches; breadth .86 inch; apical angle convex, divergence 50°.

In many respects this species approaches our *F. Newberryi* (Proceed. Acad. Nat. Sc. Philada. vol. 8, p. 66,) but differs in the greater elevation of its spire, more elongated form, and stronger, as well as more distant revolving lines. It also has about one more volution, and the apical angle measures 5° less.

Like *Fusus Newberryi*, in the prominence of the middle of the outer lip, and consequent subsinuate character of its upper part, this shell approaches some varieties of *Pleurotoma*, but appears to be a true *Fusus*.

Locality and position. Yellow Stone River, 150 miles above its mouth, in a bed apparently a blending of No. 4 and 5 of our section.

FUSUS (PLEUROTOMA ?) SCARBOROUGHII.

Shell fusiform; spire conical, acute at the apex; volutions about six and a half, flattened, or slightly concave above; last one contracting abruptly below into a small (rather short?) canal; suture small, not deeply impressed; surface ornamented by fine regular lines of growth, crossed by numerous distinct, rather closely arranged, elevated, thread-like lines, which are slightly variable in size, but generally equalling the spaces between; sometimes more closely crowded and smaller just below the suture, than on the middle of the whorls; aperture narrow ovate, angular above, tapering into the canal below; outer lip thin, 1857.]

prominent near the middle, and having a broad faint sinus above; columella slightly arcuate. Length about 1.42 inches; breadth .67 inch; apical angle very convex, divergence 408.

Not having seen a specimen of this species showing very clearly the form of the outer lip, we are left in some doubt as to whether it is not more nearly related to *Pleurotoma* than *Fusus*. The lines of growth, are so deflected below the suture, as to indicate the presence of a broad faint sinus in the upper edge of the lip, as in *Pleurotoma*; the general aspect of the shell, however, is more like *Fusus* than *Pleurotoma*. It is probably one of those connecting links between those genera, often met with amongst fossil species. None of our specimens show the entire length of the canal, but we are inclined to think it was not very long.

There is no other shell in the Nebraska formation No. 5 known to us, resembling this in other respects, that has so remarkably convex a spiral angle, the convergence from the first to the second volution being only about 30°, while the angle at the apex is as much as 48°.

We have named this species in honor of Mr. George Scarborough, of Owensboro', Ky., a quiet but devoted cultivator of natural science.

Locality and position. Butte aux Gres, on the Missouri River, formation No. 5 of the section.

New Gen. PSEUDOBUCINUM.

Owing to the fact that the limits of the great genus *Buccinum* are badly defined, and several attempts have already been made to erect into distinct genera, forms regarded by many of the ablest conchologists as merely sections of that genus, it is with hesitation we venture to propose for a shell of this type a new generic name. Although evidently related to *Buccinum*, the species before us presents, we think, an ensemble of characters of sufficient importance to be regarded as the type of a distinct group. In the first place, it differs remarkably from the species of that genus known to us, in the deeply arcuate and strongly tortuous character of its columella, as well as in the comparatively large size of the body volution and aperture. So distinctly marked are these characters, that it appears probable, if the matrix were removed from the inside of the shell, the whole interior, quite to the apex of the spire, would be visible from below. It likewise differs from any of the species of *Buccinum* coming under our observation, in being a much thinner shell, and in having, instead of a short reflexed canal or deep notch at the base of the columella, simply a small rounded sinus.

In form and general appearance it resembles *Sulcobuccinum* of D'Orbigny, and *Pseudoliva*, of Swainson; but differs from them both in its strongly arcuate and tortuous columella, as well as in wanting the revolving sulcus on the exterior of the body whorl. It is also a much thinner shell than we have seen amongst the species of either of these types, and wants the small notch in the outer lip, characteristic of the first, and the projecting spine on the inner side of the same in the other.

As it is not possible to give definitely the characters of a genus, of which but a single species is known, we will for the present merely repeat a description given on a former occasion of this shell, without attempting to separate the specific characters from those that may be only of specific importance.

PSEUDOBUCINUM NEBRASCENSIS.

Buccinum? Nebrascensis, M. & H., *Proceed. Acad. Nat. Sci.* Vol. 8, p. 67.

Shell oval, thin; spire very short; volutions three to three and a half, convex, rapidly increasing from the apex, last one very large and somewhat ventricose; surface marked with distinct lines of growth, which are crossed by flattened revolving bands, much wider on the upper part of the volutions than the shallow grooves between, but about equalling them on the lower part of the last turn. About seven or eight of these bands may be counted on the second volution; suture narrow and slightly channeled; aperture large, subelliptical,

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angular above, and terminating in a rather small, rounded sinus below, the form of which is well defined by a sudden curve in the lines of growth on a broad spiral ridge round the edge of the pillar lip; outer lip very thin; inner lip thinly spread over the extremely tortuous columella. Length .77 inch; breadth .58 inch; length of aperture .61 inch, breadth of do. .36 inch; apical angle convex, divergence 105°.

Locality and position. Moreau Trading Post and Fox Hills, No. 5 of the series.

XYLOPHAGA ELEGANTULA.

Shell small, globose-cordate, very ventricose; posterior rounded and closed; anterior having a profound angular notch in the under part, so as to produce a very large hiatus extending more than one-third the length of the shell back from the buccal extremity, and above the middle; beaks elevated, gibbous, very strongly incurved and placed a little in advance of the middle; surface ornamented by small regular concentric wrinkles and very fine lines of growth; the wrinkles are rather obscure on the posterior part of the shell, but upon reaching a narrow sulcus, which passes from the beaks to the base, a little in advance of the middle of the shell, they suddenly become more distinct, and are deflected upwards nearly parallel with the vertical margins of the hiatus, near which they again become very fine and regular; on passing upon that portion of the valves extending out in front over the hiatus, these fine wrinkles are deflected, almost in a horizontal direction, and suddenly enlarged, but rapidly diminish, and converge as they pass round the anterior extremity.

On the cast, the mesial sulcus extending from the beaks to the base is very narrow but deep and sharply defined. At the points where the concentric wrinkles cross this sulcus or groove, it is distinctly punctate. Further back, a rather distinct carina extends from the back part of the beaks obliquely backwards and downwards nearly to the base of the shell; immediately behind this ridge, the posterior part of the cast is suddenly compressed, and faintly marked by a large leaf-like muscular impression. The pallial impression is narrow, stands nearly vertical, and extends more than half way up to the beaks between the mesial sulcus and posterior carina.

Locality and position. Muscle shell River, where it was found embedded in fossil-wood,—formation No. 4.

XYLOPHAGA STIMPSONI.

Shell ovate, gibbous in front, and cuneate behind; posterior end obliquely subtruncate above, round below, nearly or quite closed; anterior having a distinct angular notch below, which forms a large hiatus extending back one-fourth the length of the skull and upwards above the middle; base and dorsal margins parallel; beaks not much elevated above the dorsal edge, pointed at the apex, and strongly incurved. Surface marked by distinct, regular concentric wrinkles, and extremely fine lines of growth. The wrinkles are more obscure on the posterior part of the shell, but on crossing a narrow sulcus (in the cast) that passes from the beaks to the base, they become more distinct, and curve gracefully upwards nearly parallel with the edge of the hiatus; on passing forward upon the upper anterior part of the valves extending out over the hiatus, they are suddenly deflected in a horizontal direction and become stronger, but rapidly diminish and converge in passing round the anterior extremity.

On the cast, the mesial groove extending from the apex of the beaks obliquely downwards and a little backwards to the base, is narrow but well defined. A little in advance of this, and nearly parallel with it, a fainter impressed line passes from the beaks to the base. About half way between the mesial groove and the posterior end of the shell, another deep, but broader, groove extends from the posterior side of the beaks obliquely backwards nearly to the lower part of the anal extremity; behind this the narrow oval posterior muscular impression is seen faintly indicated near the border.

Although resembling the last in its style of ornament, this is a very distinct 1857.]

species, being ovate in form instead of globose-cordate. It also differs in having greatly less elevated beaks.

We dedicate the species to Mr. W. Stimpson, Naturalist of the South Pacific Exploring Expedition, to whom we are under obligations for suggestions respecting this and the preceding species.

Locality and position. Same as last.

PHOLADOMYA SUBVENTRICOSA.

Shell longitudinally oval, ventricose in the umbonial and buccal regions, more compressed behind; extremities rounded; base forming an elliptic curve; dorsum concave behind the beaks, declining very abruptly in front; beaks elevated, gibbous, located near the anterior end, distinctly incurved; surface ornamented by about thirty very small, rather flexuous, radiating costæ, some of which die out before reaching the beaks, crossed by faint concentric wrinkles, and fine rather indistinct lines of growth, which produce on the costæ very small irregular nodes or granules; costæ most distant near the extremities of the shell, and wanting on an oval or cordate space at the anterior end. Length about 2 inches; height 1.10 inch; breadth 1.10 inch.

This shell resembles very nearly a Lower Green sand species described by Prof. Forbes in the Journ. Geol. Soc. Lond. vol. i. p. 238, pl. 2, fig. 3, under the name of *P. Martini*; but the beaks are more elevated, and nearer terminal in our shell, and the costæ more numerous. The concentric wrinkles likewise differ in being not quite so distinct as on *P. Martini*.

It is yet more closely allied to a species described by one of the writers* in Trans. Albany Institute, vol. 4, p. 42, from Vancouver's Island, under the name of *P. subelongata*; but has more elevated beaks, and finer, as well as more numerous costæ; the buccal end is also more gibbous than in *P. subelongata*.

Locality and position. Mouth of Judith River, formation No. 1? of general section.

SOLEN? DAKOTENSIS.

Shell long and slender, rather compressed; dorsal margin and base parallel; posterior end narrowly rounded, (anterior end?); beaks not distinct from the dorsal edge, located near the centre of the shell; surface of cast marked by very obscure traces of concentric wrinkles, indicating the direction of lines of growth. Length 1.40 inch; height .35 inch; breadth about .20 inch.

This species resembles *S. æqualis*, D'Orbigny, (Pal. Franc. tom. 3d, pl. 350, figs. 5, 6,) more than any shell with which we are acquainted; but is proportionally narrower, and the beaks are less distinct from the cardinal border. The only specimen we have seen is a cast of the outside of both valves, lying partly open and embedded in the matrix. Although we know nothing of the surface markings or interior of this shell, we have ventured to characterize it, believing it important to call attention to the few forms found in the formation in which it occurs, however obscure they may be, as there remains some doubt in regard to the exact age of this deposit.

Locality and position. Just below the mouth of Vermilion River on the Missouri, formation No. 1 of general section.

New Gen. CORBULAMELLA.

The small shell upon which we propose to establish the above genus appears to be related both to *Cardilia* of Deshayes, and *Corbula* of Bruguiere. It differs from the first, however, in being distinctly inequivalve, and in wanting the spoon-shaped projection for the reception of the ligament, mentioned by Deshayes. From *Corbula* it differs in having the posterior muscular attachment raised upon a thin, strongly projecting plate, as in *Cucullæa*. The teeth of the hinge, and pallial impression appear to be as in *Corbula*. We have not been able to determine whether the ligament was internal or external.

* Mr. Meek.

As this shell appears to agree in so many characters with *Corbula*, the propriety of separating it from that genus may be doubted by some; it presents, however, such a marked difference from any species of *Corbula* we have seen, in the peculiar very strongly projecting internal plate above referred to, that we are satisfied there must have been some corresponding difference in the organization of the animal.

As we have hitherto met with but the one species, it is of course impossible to determine, in every instance, which of its characters are of specific, and which of generic importance, consequently we will not attempt to give a formal diagnosis of the genus, but will merely repeat, with slight modifications, the description given by us some little time back in the Proceedings of the Academy.

CORBULAMELLA GREGAREA.

Corbula? gregarea, M. & H., *Proceed. Acad. Nat. Sci.* Vol. viii, p. 84.

Shell very small, inequivalve, approaching subglobose, a triangular form, right valve more ventricose than the other; beaks nearly central, gibbous, that of the right valve elevated above the left, incurved; surface polished and marked with a few faint irregular concentric wrinkles of growth; hinge having under the beak a single prominent tooth in each valve; anterior muscular attachment rather indistinct, posterior raised upon a strongly projecting lamina; pallial impression scarcely sinuous. Length .13 inch; height .13 inch; breadth .10 inch.

Locality and position. Occurs in great numbers on Yellow Stone River in a bed apparently a blending of No. 4 and 5.

CYPRINA ABENAREEA.

Cast of interior very broad ovate, subtrigonal, moderately compressed, most convex in the umbonial region; extremities rounded, the posterior sometimes slightly truncate; base semi-ovate or broadly rounded; dorsal margin sloping rather abruptly, with a regular convex curve from the beaks to the posterior end, concave and much more abruptly declining in front; beaks rather elevated, slightly gibbous, located a little in advance of the middle of the shell. Length .95 inch; height .80 inch; breadth .53 inch.

This species has much the form and general appearance of a *Cytherea*, but as there is no indication of a sinus in the pallial impression, on any of the casts we have seen, and the teeth of the hinge, as near as can be ascertained from internal cast, are like those of *Cyprina*, we place it provisionally in that genus.

Locality and position. Big Sioux River, two miles above the mouth, in sandstone of formation No. 1, where it is associated with fragments of fossil wood bored by *Teredo*.

CYPRINA CORDATA.

Shell thick, cordate, gibbous; extremities and base rounded; umbonial region ventricose; beaks much elevated, nearly central, distinctly curved obliquely inwards and forwards; muscular impressions not very deep, surface marked by strong concentric lines, and small wrinkles of growth, crossed by faint traces of radiating lines. Length 1.66 inches; height 1.68 inches; breadth about 1.49 inches.

As we have not yet seen the hinge of this shell, we are in some doubt in regard to its affinities; and only place it provisionally in the genus *Cyprina*. The character of the muscular impressions, with its simple pallial line, and general appearances, are such as to indicate its relations to that genus. It will be at once distinguished from all the other forms we have yet seen from the Nebraska rocks, by its high curved beaks, gibbous cordate form, and distinct lines of growth; the radiating lines mentioned above are so very faint as to be readily overlooked, excepting when the shell is viewed in a certain light, and may be often absent.

Locality and position. Moreau River, No. 5 of the series.
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CYPRINA COMPRESSA.

Shell broad ovate, rather thin and compressed, somewhat narrowly rounded at the extremities, base semi-oval; beaks elevated, approximate, not strongly curved, located about three-eighths the length of the shell back of the anterior end; cardinal border declining rather abruptly, with a greatly convex outline, from the beaks towards the posterior end, concave and more abrupt before the beaks; surface unknown; muscular impressions rather distinct. Length 2.66 inches; height 2.17 inches; breadth about 1.15.

We are not sure we have seen specimens of this species showing the surface characters; some fragments in the collection from the same locality and position apparently of the same shell, are simply marked with rather strong lines of growth. It is barely possible this may be a variety of the last; the beaks, however, are so much more elevated, and farther removed from the anterior end, that we are at present inclined to regard it as a distinct species.

Locality and position. Same as last.

CYPRINA SUBTUMIDA.

Shell rather small, ovate, moderately gibbous; anterior end narrowly rounded below the beaks; posterior subtruncate at the extremity; base forming a gently convex curve, contracted towards the posterior; cardinal border declining with a long gentle curve from the beaks to the posterior end, concave and very abrupt in front; beaks located near the anterior end, directed obliquely forward, not much elevated; umbonal region gibbous; valves prominent or almost subangular from near the beaks obliquely backwards towards the lower part of the posterior end; muscular impressions not deep, anterior ones smaller and more distinct than the others; surface unknown. Length (of cast) .92 inch; height .65 inch; breadth .55 inch.

This species is not very nearly related to any we have seen figured in foreign works, and may be known from any of those we have described from the North West, excepting *C. cordata*, by its more gibbous form, more ventricose and oblique umbonal slopes, as well as less elevated beaks. From *C. cordata* it will be at once distinguished by its ovate form and greatly less elevated beaks.

Our specimens do not show very satisfactorily the surface markings, as the exterior has been mainly removed by the exfoliation of the shell. There are, however, indications of lines of growth, and on the surfaces of the laminæ faint traces of radiating marks; though the latter may have had no connection with surface markings. Not enough of the shell remains to show the character of the points of the beaks.

Locality and position. Yellow Stone River, in beds apparently a blending of No. 4 and 5.

CYPRINA OVATA.

Shell ovate, compressed, rather thin, somewhat narrowly rounded at the extremities; base semi-ovate; cardinal border declining with a gentle curve from the beaks towards the posterior extremity, concave and sloping more abruptly in front; beaks not much elevated, rather small, approximate, not strongly curved, located a little more than one-fourth the length of the shell behind the anterior border; surface ornamented by distinct concentric lines of growth; lunule small, and not distinctly defined; corselet lanceolate, profound; hinge moderately thick, lateral teeth long; cardinal teeth not very prominent; muscular and pallial impressions distinct, but not deep. Length 2.55 inches; height 2.05 inches; breadth 1.15 inches.

This species resembles *C. oblonga*, D'Orbigny, (Pal. Franc. tom. 3d, p. 103, pl. 277, fig. 1-4.) but is more narrowly rounded at the extremities, and the lateral tooth of the right valve is not near so prominent.

Locality and position. Mouth Heart River, at junction of formation No. 5 of the general section with the base of the Tertiary, but probably in the former.

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UNIO DANAI.

Shell elongate, arcuate, and oblique, contracting posteriorly; anterior end regularly rounded; base slightly arched, most contracted a little behind the middle; posterior end cuneate, rather narrowly rounded; dorsal margin sloping with a long convex curve from near the umbones towards the posterior end; beaks depressed, not very distinct from the dorsal edge, placed a little more than one-fourth the length of the shell from the anterior end; flanks concave from the umbonal region obliquely downwards to the most arcuate portion of the base; hinge moderately thick; cardinal teeth corrugated, strong, apparently double in the left valve, and single in the right; lateral teeth long and slender; surface (of specimens with the epidermis removed) marked by faint lines of growth, and very obscure radiating striæ. Length 3.50 inches; height 1.54 inches; breadth about 1 inch.

After satisfying ourselves that this and the two following species are distinct from all the fossil *Uniones* described in any works within our reach, we submitted them to Mr. Isaac Lea, the well-known conchologist of Philadelphia, from whom we received the following remarks respecting their affinities to recent species.

"The specimen marked *Unio Danai* has very much the same outline with *Margaritina margaritifera*, Schm., but is a true *Unio*, and perhaps more nearly allied to *U. tumidus*, Retzius, than to any other of the genus. It is certainly an undescribed species.

"*Unio Deweyanus* is a very distinct species, and although not more than half the size, very closely resembles the recent *U. truncatus*, Swainson, in outline and obliqueness. It is also, like it, a thick ponderous species.

"*Unio subspatulatus* is an oblique species, nearly allied to *U. spatulatus*, Lea, but is more rounded posteriorly than that shell.

"All these species are characterized by an obliqueness not usual in the genus. The beaks are nearly terminal in all of them, and they have a general massive character, which causes a disposition to enlarged cardinal and lateral teeth. This enlargement is more particularly noticeable in the cardinal teeth, which are all massive and very much corrugated. It is evident from the deep corrugations of the great cicatrices, that the muscular power of the animal was very great.

"They are certainly very interesting specimens, and deserve attention, as they differ much from the general type of recent *Uniones*, as well as those of the Wealden of England."

Owing to the fact that these shells were obtained from a formation in which saurian remains, similar to some of those of the Wealden were found, we called Mr. Lea's attention to that fact, with the view of also obtaining his opinion respecting their affinities to Wealden forms. From his remarks above, it will be seen he is of the opinion they are distinct from the types of that epoch. Mr. Lea's opinion on this point is of much value, since he had an opportunity, while in England some years since, of studying very carefully Dr. Mantell's extensive collection of Wealden species.

We name this shell in honor of Prof. James D. Dana, the distinguished naturalist of New Haven, Connecticut.

Locality and position. Mouth of Judith River, bed G. of the freshwater and estuary deposits at that locality.

UNIO DEWEYANUS.

Shell rather thick, oblique, narrow-ovate, approaching a narrow-elliptic form, most convex in the umbonal region, more compressed and cuneate posteriorly; extremities rounded, anterior end a little wider than the other; base broad, semi-ovate; dorsal margin nearly straight, and sloping gradually from near the beaks towards the posterior end; beaks small, not very distinct from the dorsal border, almost terminal in old shells, but in young individuals a
1857.]

little more removed from the buccal margin; surface (of specimens with the epidermis wanting) showing obscure lines of growth, crossed by very fine indistinct irregular radiating striæ; ligament long; hinge much thickened at the anterior end of the valves, composed of two rough irregular cardinal teeth in the left valve, and one more prominent tooth in the right; lateral teeth long and slightly arched; dorsal cicatrix located nearly under the beaks, not very deep; anterior cicatrix distinct, and strongly corrugated; cavity of the beaks shallow. Length about 2.60 inches; height 1.33 inches; breadth about 1.18 inches.

Named in honor of Rev. Chester Dewey, of Rochester University.

Locality and position. Bed G. of the freshwater and estuary formations at the mouth of Judith River. (See section at that place.)

UNIO SUBSPATULATA.

Shell moderately thick, oblique, elongate-ovate, rather compressed, most convex at the anterior end, cuneate behind; buccal end wider than the other, abruptly rounded or subtruncate; posterior end narrowly rounded; base nearly straight or very slightly concave; dorsal margin sloping a little, with a long, convex curve from near the umbones, towards the posterior end; beaks small, not much elevated, located at the anterior end; surface (epidermis gone) showing faint lines of growth, crossed by fine irregular, radiating striæ; hinge and interior unknown. Length 2.83 inches; height 1.34 inches; breadth .75 inch.

This species is related to *U. Danai* of this paper, but is more compressed, and its base and flanks are less contracted. It likewise presents the well marked difference of having terminal beaks, while those of *U. Danai* are removed about one-fourth the length of the shell back from the anterior end.

From *U. Deweyanus* of this paper, to which it is also related, it differs in being more elongated and compressed. It is also more arched on the back and more contracted along the lower border.

Locality and position. Same as last.

PECTUNCULUS SUBIMBRICATUS.

Shell transversely oval, nearly circular, not much compressed, equilateral; extremities rounded, posterior end sometimes slightly broader than the other; base rather more broadly rounded; cardinal border slightly arched, moderately thick; beaks (obtuse?) not much elevated or incurved; surface ornamented by about fifty simple, rounded, depressed radiating plications, a little more than twice as broad as the grooves between, crossed by numerous regular, distinct, imbricating lines of growth, which arch upwards in crossing the costæ; cardinal teeth about twenty-five, not large, lateral ones arcuate, with the concave sides turned from the beaks; ligament area moderate, marked by about six grooves, which form very obtuse angles under the beaks; muscular impressions large but not deep. Length 1.49 inches; height 1.36 inches; breadth 1.02 inches.

Associated with the above we have a single valve of another individual not more than one-sixth as large, and having comparatively a smaller ligament area, fewer teeth and rather less prominent beaks. The costæ are also apparently obsolete over proportionably larger spaces at the extremities of the hinge. This we suspect may be a distinct species, but without more specimens for comparison we are unwilling to so regard it at present. If it should prove to be a different species we would suggest for it the name of *P. suborbiculatus*.

Locality and position. Heart River, near junction of No. 5 with the Tertiary, but perhaps in the former.

OSTREA GLABRA.

Shell elongate-ovate, rather irregular, usually curving to the left, but sometimes to the right; generally narrower near the beaks than at the other ex-
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tremity. Lower valve rather deep; ligament area small and well defined; beaks somewhat pointed at the extremity, most frequently turned abruptly to the left; umbonial region sometimes a little distorted by the cicatrix of attachment. Upper valve flat, or a little concave; beak truncated at the extremity. Surface smooth, or only marked by very small, faint concentric wrinkles of growth. Length about 3 inches; breadth 1.50 to 2 inches.

Locality and position. Mouth of Judith River, in sandstone of formation No. 1? of general section.

OSTREA TRANSLUCIDA.

Shell small, thin and translucent, arcuate, attached by the under side of the lower valve in the umbonial region; border having faint indications of three or four broad undefined plications; beaks small, more or less distinctly curved to the left; lower valve convex, rather deep; ligament area very small and triangular, sometimes linear and abruptly curved to the left; margins on each side of the beak regularly and rather distinctly crenulated; muscular impression ovate, small, very near the left border, indistinct; upper valve nearly flat, or slightly concave near the middle, sometimes distinctly alate on the left side at the beak, regularly and closely rounded on the other side; cardinal end transversely truncate; beak not extending beyond the truncated cardinal edge, but curving round to the left within the margin; surface nearly smooth, or marked only by faint subimbricating lines of growth. Length about 1 inch; breadth .53 inch; depth of lower valve .30 inch.

This species resembles *O. larva* of Lamarck, and is the shell referred by us with doubt to that species in the catalogue of Nebraska Cretaceous and Tertiary fossils given in our last paper. A comparison of better specimens in the late collections, with authentic specimens of *O. larva* proves them to be quite distinct. Our shell never being near so distinctly plicated round the border as that species, nor is it auriculate on both sides of the beak as in *O. larva*. Its mode of attachment is likewise altogether different, being more like *O. crenulata* of Tuomey, in that respect; it also sometimes resembles the latter shell in the crenulate character of its borders on each side of the beaks, but differs in wanting the closely plaited squamose ridges mentioned by Prof. Tuomey.

Locality and position. Long Lake on the Missouri, in the upper part of No. 5 of the section.

HEMIASTER? HUMPHREYSANUS.

Shell broad cordate or subcircular, rather depressed, greatest elevation near the posterior, declining very slightly towards the front; broadest a little in advance of the middle, rather flat below; oral aperture, not large, transversely oval, arcuate, with convex side towards the front, located about one-fourth the length of the shell from the anterior end; vent small and of an oval form; apical disc not more than one-third the length of the shell in advance of the posterior end; genital pores four, rather large; dorsal ambulacra, excepting the odd one, distinctly petaloid, very unequal; anterior or odd one long, lanceolate, and extending nearly to the margin, located in a deep rounded groove which passes over the front to the mouth, giving an emarginate character to the anterior end, having about thirty-three pairs of pores in each series; anterior lateral ambulacra flexures a little broader than, and not quite so long as, the odd one, placed in distinct grooves, and having about thirty-five or six pairs of pores in each series; posterior ambulacra very small, not much more than one-third as long as the anterior laterals, oval in form, and having about eighteen pairs of pores in each series, not deeply excavated; inter-ambulacral spaces prominent, anterior two rather pinched up; surface unknown. Length 1.21 inch; height .81 inch; breadth 1.20 inch.

Not having seen specimens showing the surface markings of this species, it is with some doubt we refer it to the genus *Hemister*, the absence of the shell 1857.]

leaving some doubts in regard to the presence of the fasciale characteristics of that genus. The posterior position of the apical disc, and the close proximity of mouth to the front, as well as the great inequality of the posterior and anterior lateral ambulacra, appear to remove it from the genus *Toxaster*. In some respects it resembles the genus *Schizaster*, but does not decline so distinctly towards the front above, as is common amongst the species of that genus. It may belong to a new type.

It is remarkable, that in all the collections hitherto obtained from the Cretaceous rocks of Nebraska, this is the only species of *Echinoderm* yet met with, and it is so rare that but the single specimen now before us, and a fragment mentioned in one of our former papers, from the same locality, have been met with.

We take pleasure in naming this rare and beautiful fossil in honor of Capt. A. A. Humphreys, of the U. S. Topographical Engineers.

Locality and position. Yellow Stone River, in a bed composed of a blending of No. 4 and 5 of the general section.

On the LARVA of the *Thyreus Abbottii*.

BY J. P. KIRTLAND, M. D.

Swainson, in his Zoological Illustrations, vol. i. First Series, described the *Thyreus Abbottii*, which, together with the Pupa and Larva, he figured on the authority of Mr. Abbott's unpublished drawings.

Dr. Harris' Catalogue of North American Sphinges, in the Amer. Jour. of Sciences and Arts, vol. xxxvi., contains also a description of this larva, drawn from Swainson's sketch. With due deference to these high authorities, I beg leave to state, that neither their figures nor descriptions bears the least resemblance to the true larva.

During the last three years I have reared many of them and carried them through the second stages of transformation to the perfect insect.

At maturity the Larva is about the length of Swainson's figure, but its diameter is one-fifth less. Its upper surface is ash color, with its belly and legs tinged with a faint violet. It is not furnished with a caudal horn as represented in Swainson's figure, but in place of it has an oval eyelet or occuli, of a glossy brown color, and a line or two in diameter. This Larva resembles more the common silk worm (*Bombyx mori*) than it does Swainson's figure. Its principal food is the leaf of the *Ampelopsis quinquefolia*, though it occasionally is found on the cultivated grape vine.

During the month of August it attains its full size, and individuals may be seen at night descending to the ground, where it enters the pupæ state, below the reach of frost.

Specimens kept in boxes of earth beneath the shelves of a warm green house, appeared in the perfect state as early as the first of April, while those preserved in a cool cellar did not assume that form till late in May, or early in June.

That Dr. Harris was led into an error by Swainson's figure I have no doubt, for Dr. H. sent me a drawing and colored figure of this *true* Larva four years since, requesting of me information as to the perfect insect it produced. To prevent a further extension of that error is the object of this communication.

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